MARCH 1941

No. 3

WORLD PETROLEUM

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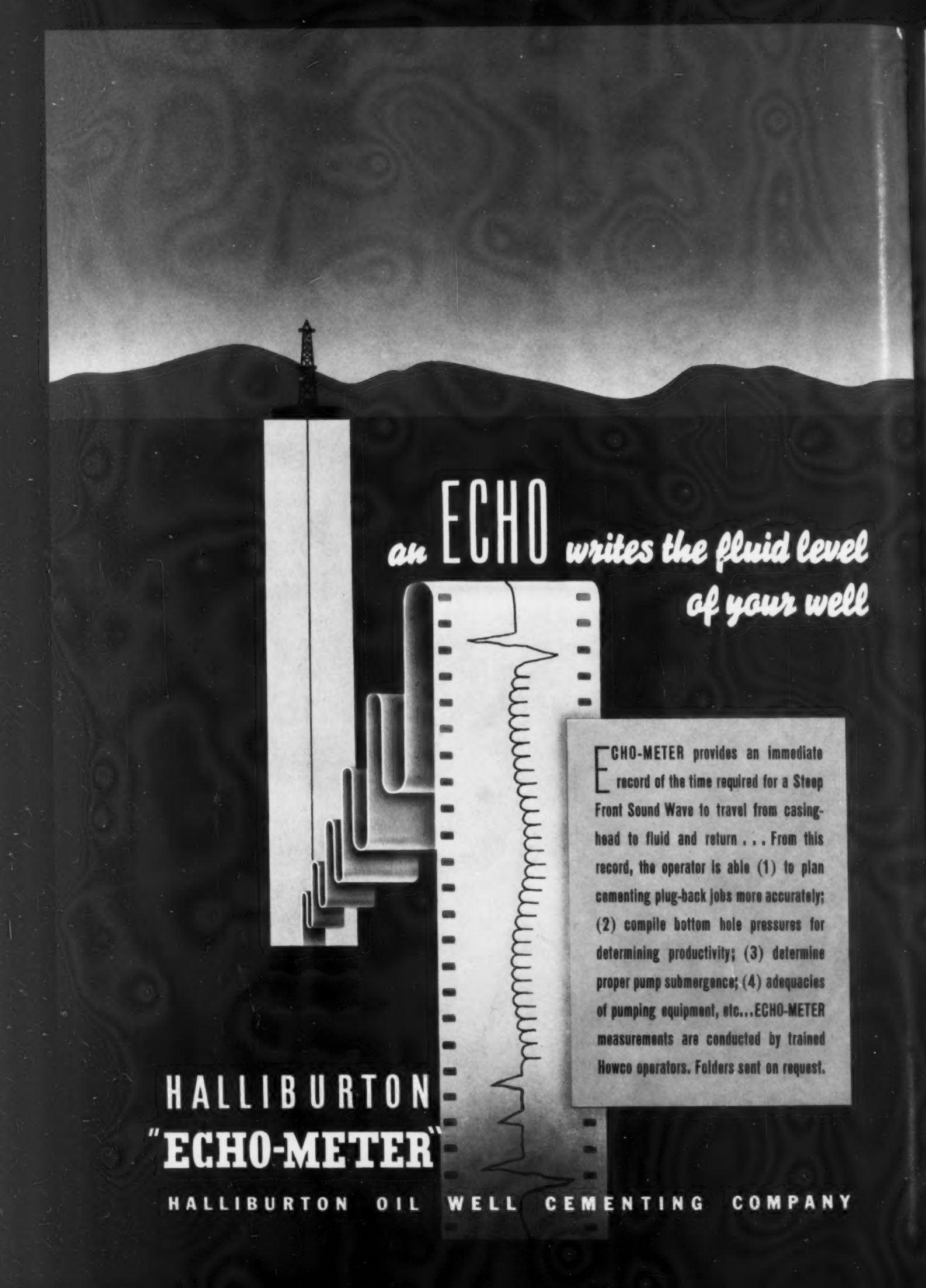
California Curtailment


an ECHO writes the fluid level of your well
ECHO-METER provides an immediate record of the time required for a Steep Front Sound Wave to travel from casing-head to fluid and return . . . From this record, the operator is able (1) to plan cementing plug-back jobs more accurately; (2) compile bottom hole pressures for determining productivity; (3) determine proper pump submergence; (4) adequacies of pumping equipment, etc...ECHO-METER measurements are conducted by trained Howco operators. Folders sent on request.
HALLIBURTON
"ECHO-METER"
HALLIBURTON OIL WELL CEMENTING COMPANY

ROUND BOLTED BONNETS

- **Approved by Construction Codes:**
  Round Bonnets meet all requirements for low or high pressure services.
- **Minimum distortion under pressure:**
  Pressure vessels tend to assume spherical shapes under stress. Only round bonnets keep distortion under pressure to a minimum.
- **Lowest Maintenance:**
  Use of round gaskets cut maintenance costs to the bone. No "fussing" with rectangular, oval and other odd shaped templates and gaskets.
- **Prolonged Service Life:**
  Vogt Bonnets and Bodies have the recognized wide safety margin of DROP FORGINGS. This, combined with correct design and proper materials assures continuous operation with highest operating efficiency.

Vogt BOLTED BONNET VALVES

UTILIZE THE *Round* BOLTED DESIGN
for *ALL SIZES and ALL PRESSURES*
THIS INCLUDES *EVEN* THE LOW-PRESSURE
150 AND 300 POUND VALVES

HAVE YOU a copy?

Vogt's complete line of Drop Forged Steel Gate Valves is described in this brochure. Sent upon request.

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NEW YORK • PHILADELPHIA • CLEVELAND • CINCINNATI
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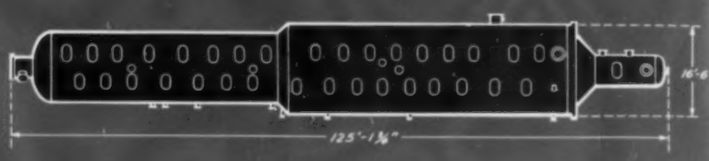
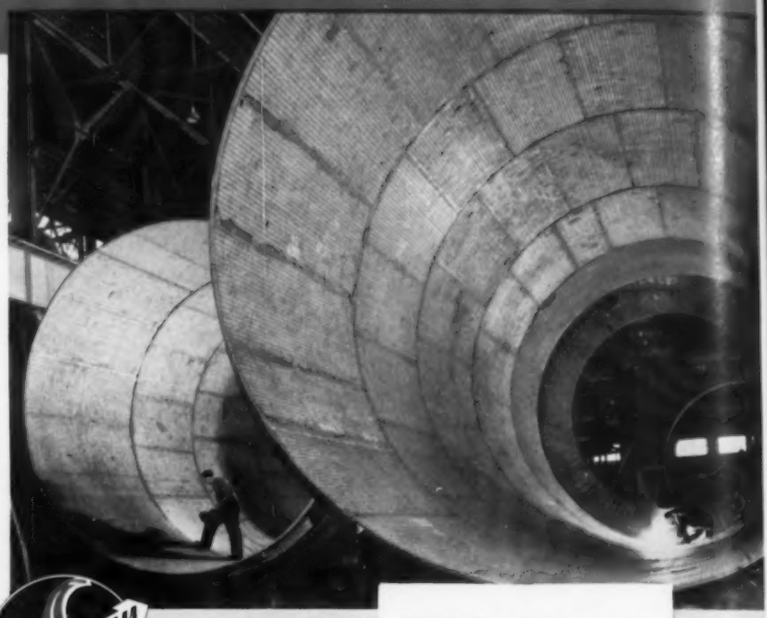
DROP FORGED STEEL VALVES

World Petroleum (including Petroleum Equipment Exporter), Vol. 12, No. 3, March, 1941. Entered as Second Class Matter, March 19, 1939, at the Post Office at Hoboken, N. J., under the Act of March, 1879. Additional entry at the Post Office at Orange, Conn. Published monthly November to September, semi-monthly in October, by Russell Palmer at 95 River Street, Hoboken, N. J.

WANTED:



TWO HUGE, COMPLEX VESSELS!



...so McKEE Came to SMITH!

TO FILL a contract from a major eastern refiner, Arthur G. McKee & Co. required two identical towers of exceptionally large size and complicated design. Specifications called for an over-all length of 125'-1¾", a maximum inside diameter of 16'-6", corrosion-resisting lining, and innumerable other construction details such as 84 manways and openings in each vessel.

The building of these huge vessels was entrusted to A. O. Smith in recognition of this firm's unusual facilities for such gigantic, exacting undertakings and eminently successful experience in solving similar problems for refiners throughout the world.

Too large to deliver complete, these towers were shipped knocked down, requiring 16 freight cars for the two units. Then they were re-assembled and welded on the site. Each tower weighed 265,000 pounds.

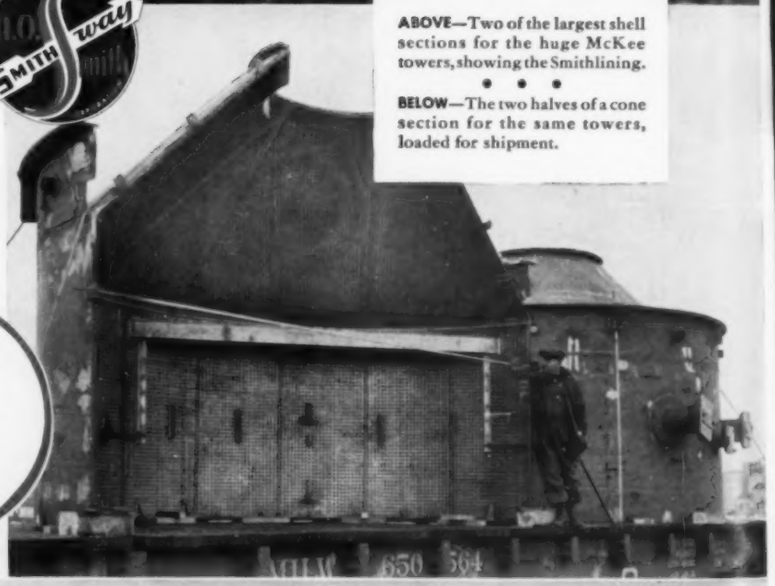
Meet the changing requirements for refinery vessels by utilizing Smith's complete production facilities, Smith's broad experience as pioneer manufacturer of welded vessels, and Smith's unparalleled knowledge in the field of corrosion resistance—the result of having originated Smithlining.

A. O. Smith Corporation, Milwaukee, Wisconsin. Offices at New York, Pittsburgh, Chicago, Tulsa, Dallas, Shreveport, Houston, Corpus Christi, Los Angeles.

ABOVE—Two of the largest shell sections for the huge McKee towers, showing the Smithlining.

• • •

BELOW—The two halves of a cone section for the same towers, loaded for shipment.



DID YOU KNOW?

- That the successful service records of A. O. Smith products result from broad knowledge of how to test materials and products *under field conditions*, and from exceptional facilities for making such tests.
- That Smith metallurgical research ranges far ahead, seeking and finding the answers to tomorrow's problems.
- That Smith's extensive metallurgical experience and knowledge might well be applied to your problems with profit to you.

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Milwaukee, Wisconsin

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WHEN YOU invest in a pumping engine, guesswork is out. The engine you buy has to be *just right* for the job. That's why so many operators choose INTERNATIONAL POWER UNITS. These engines are dependable units, backed by performance records that tell their own story of *unbeatable economy, low maintenance,* and *long life.*

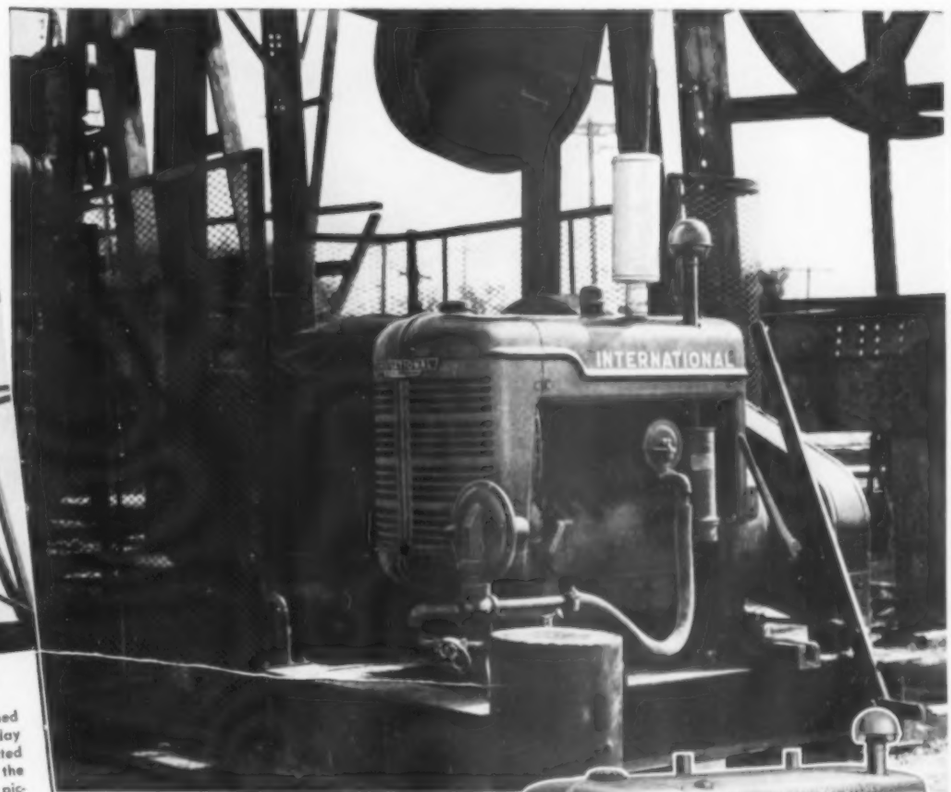
Make your power dollars go farther this year—and in the years ahead—with International Power Units. There is a complete line for every type of fuel—gasoline, natural gas, distillate, and Diesel. Sizes range up to 110 h.p. For loads requiring more power, two or more units can be installed and cut in and out as requirements vary.

There is an International industrial power dealer or Company-owned branch near you, ready to help you solve your power problems. We will also be glad to mail you a power unit catalog on request.

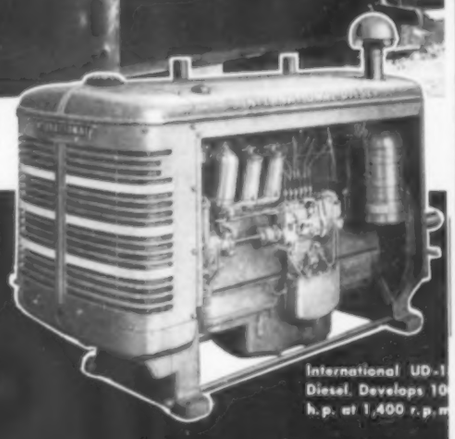
INTERNATIONAL HARVESTER COMPANY
180 North Michigan Avenue Chicago, Illinois

'WAY DOWN . . . 8,540 FEET!

This 6-cylinder International PA-100 Power Unit (110 max. h.p.) owned by Pettijohn Drilling Co., Los Angeles, is pumping 200 barrels a day of 32.5 gravity oil with a 1½-inch pump at 8,540 feet. The well, located at Imperial and Western Blvds., Los Angeles, was reported to be the deepest sucker rod pumping well in the world at the time these pictures were taken.

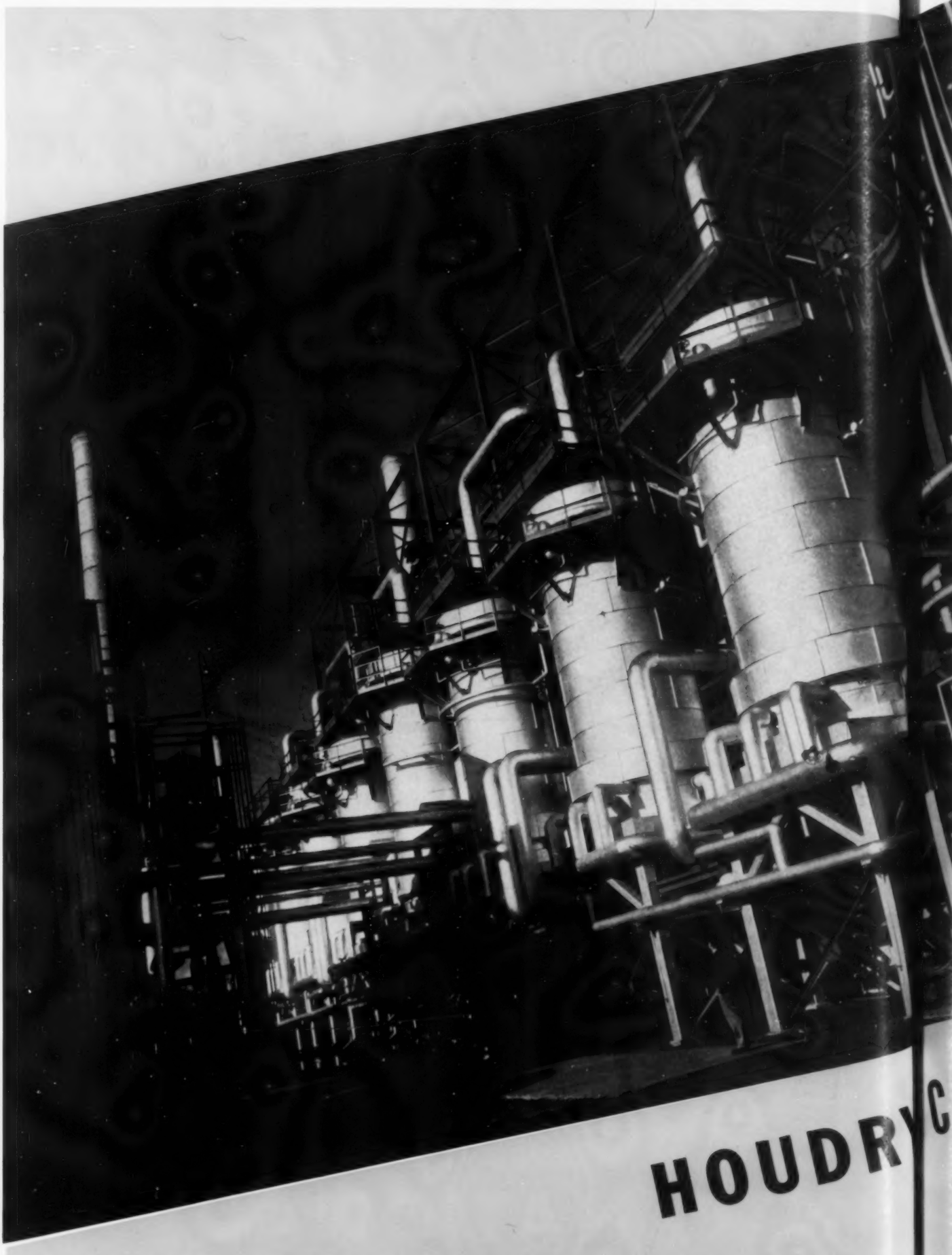


Above: Here's the compact 4-cylinder International U-2 Power Unit operating on natural gas. This engine develops 22 h.p. (on gasoline) at 1,800 r.p.m.



International UD-1 Diesel. Develops 10 h.p. at 1,400 r.p.m

INTERNATIONAL
Industrial Power



HOUDRY C

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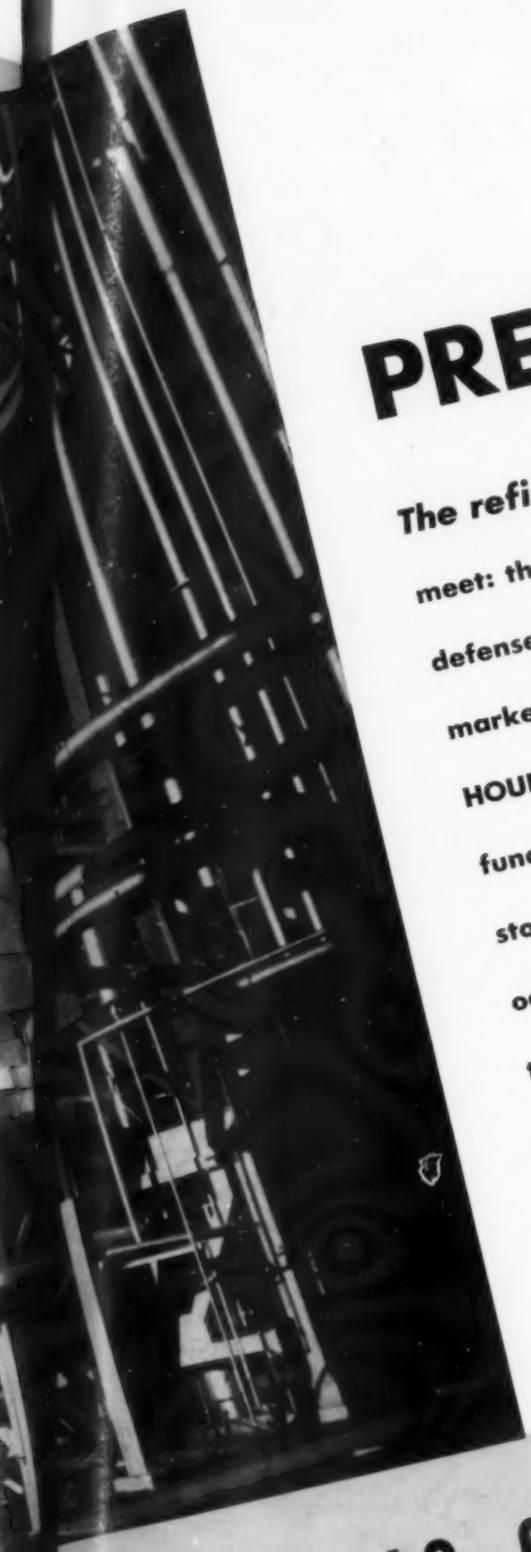

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The refiner has a program of preparedness to meet: the program of aviation fuel for national defense ★ a program for a future motor gasoline market that will demand a higher octane fuel. HOUDRY can meet your program with an ability to function on all different types of charging stocks ★ with the production always of high octane gasoline ★ with a desirable flexibility in the production of other products ★ with an operating preparedness that comes from 18 units in operation and building with a combined charge capacity of over 200,000 barrels per day.

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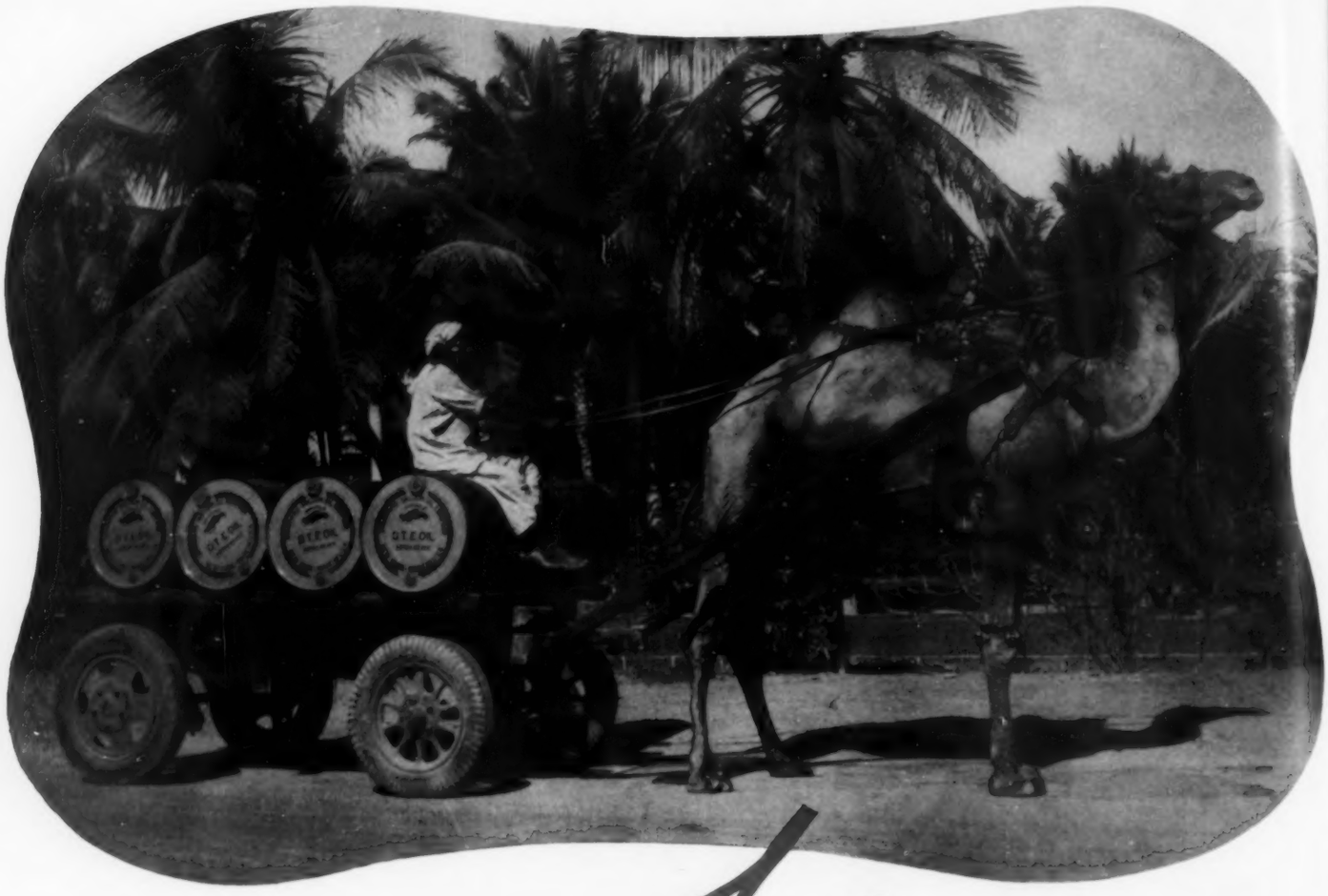

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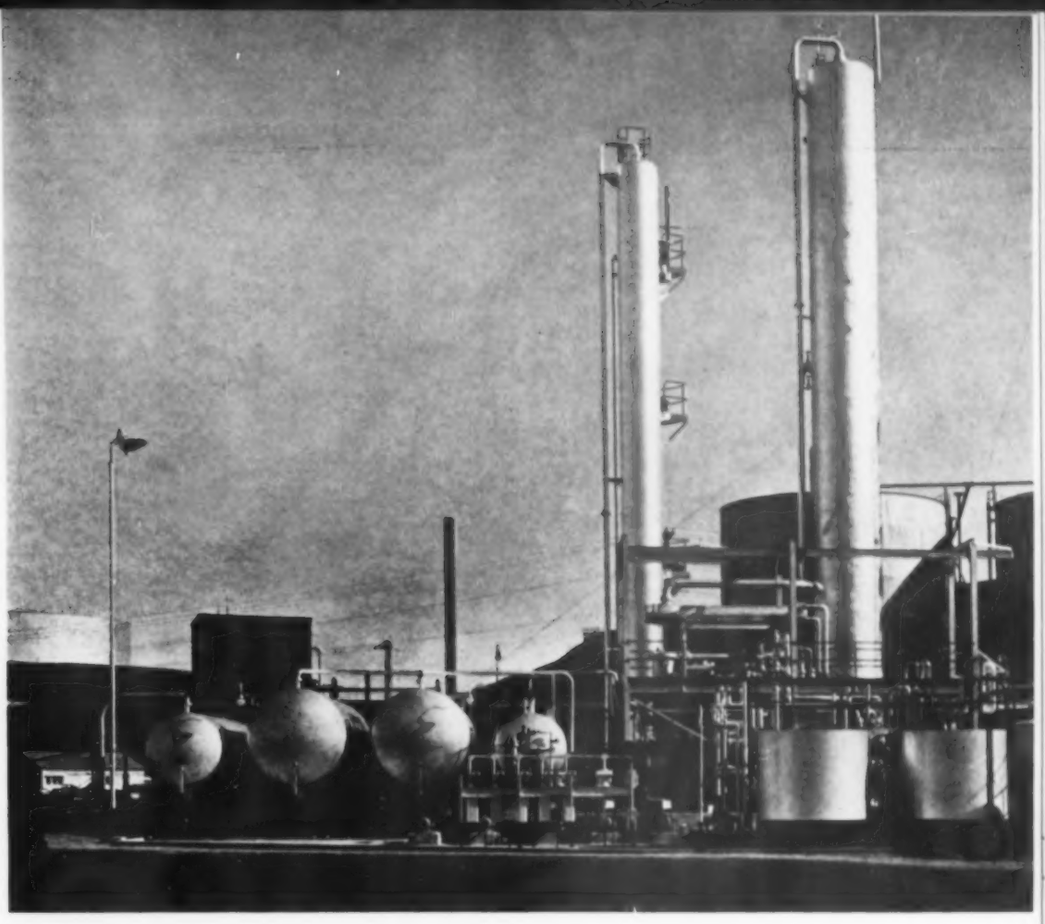

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Complete removal of mercaptans with sulphur reduction

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SELECTIVELY REMOVES H_2S FROM SOUR NATURAL GAS (or industrial gas) CONTAINING CO_2

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These are just two of a number of characteristics of the Phosphate Process which can provide you capital and operating economies

SHELL DEVELOPMENT COMPANY

LICENSORS: Shell Phosphate Process, Shell Solutizer Process, and Shell Regenerative Mercaptan Removal Process

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HELPS PUT PROFIT IN DRILL RIGS!

MANY TYPES and makes of drill rigs are making extraordinary records for speed and uninterrupted operation with the aid of dependable "Caterpillar" Diesel Engines. And the reason is that these modern Diesel engines are built for work – *tough* work – with the highest quality construction and many exclusive design features which particularly fit them for the most severe types of service.

Mexico, Venezuela, Colombia, Trinidad, Roumania, Arabia, Netherland East Indies, United States – wherever you go you'll see plenty of operations having "Caterpillar" Diesels "in charge" . . . with a dependability that's backed by the world's most complete and readily available engine-parts-and-service facilities.

When buying drilling equipment, specify "Caterpillar" Diesel Power–for dependability, portability and economy.

USE THE FUEL THAT'S HANDIEST

For added profit and convenience, choose engines that can be adapted to use the fuel which is most readily available. Through a special conversion arrangement (built by "Caterpillar"), the "Caterpillar" Diesel Engines used for drilling can be readily equipped to burn *natural gas*, or cleaned *crude oil*.

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Scene is an Illinois (U.S.A.) oil-field operation . . . two "Caterpillar" Diesel D17000 *Engines driving Gardner-Denver mud pump and Portable Rig draw works on 24-hour schedule.*

CATERPILLAR *Diesel*

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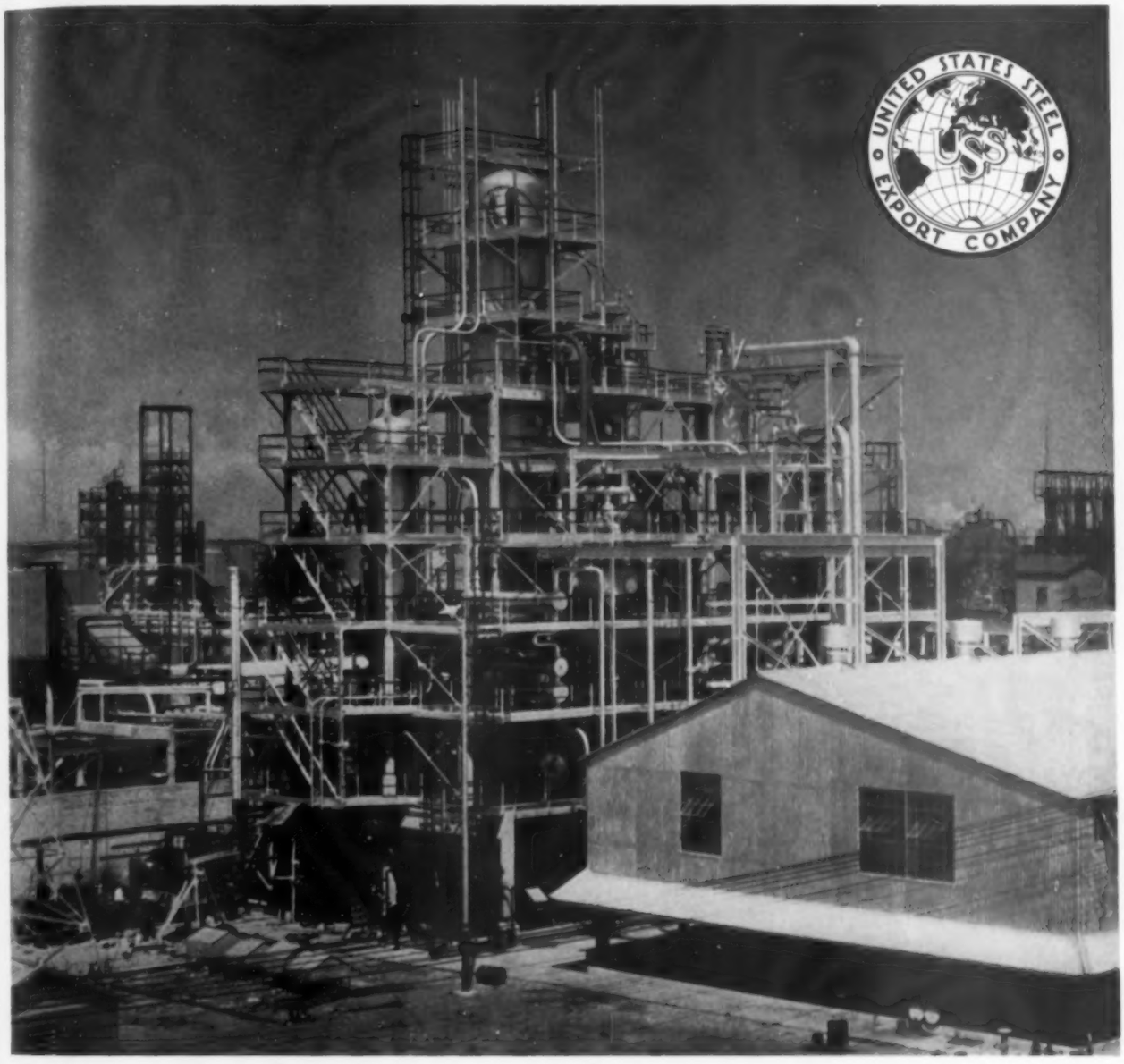

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Yes, three and three-quarter months from keel-laying to launching! We're shortening time on the ways, shortening time on delivery. But things run smoothly despite the speed-up pressure of defense. That's because we have experienced men for every key job...to see that Federal's high standards are maintained.

FEDERAL SHIPBUILDING
AND DRY DOCK COMPANY

LINCOLN HIGHWAY, KEARNY, NEW JERSEY

UNITED STATES STEEL

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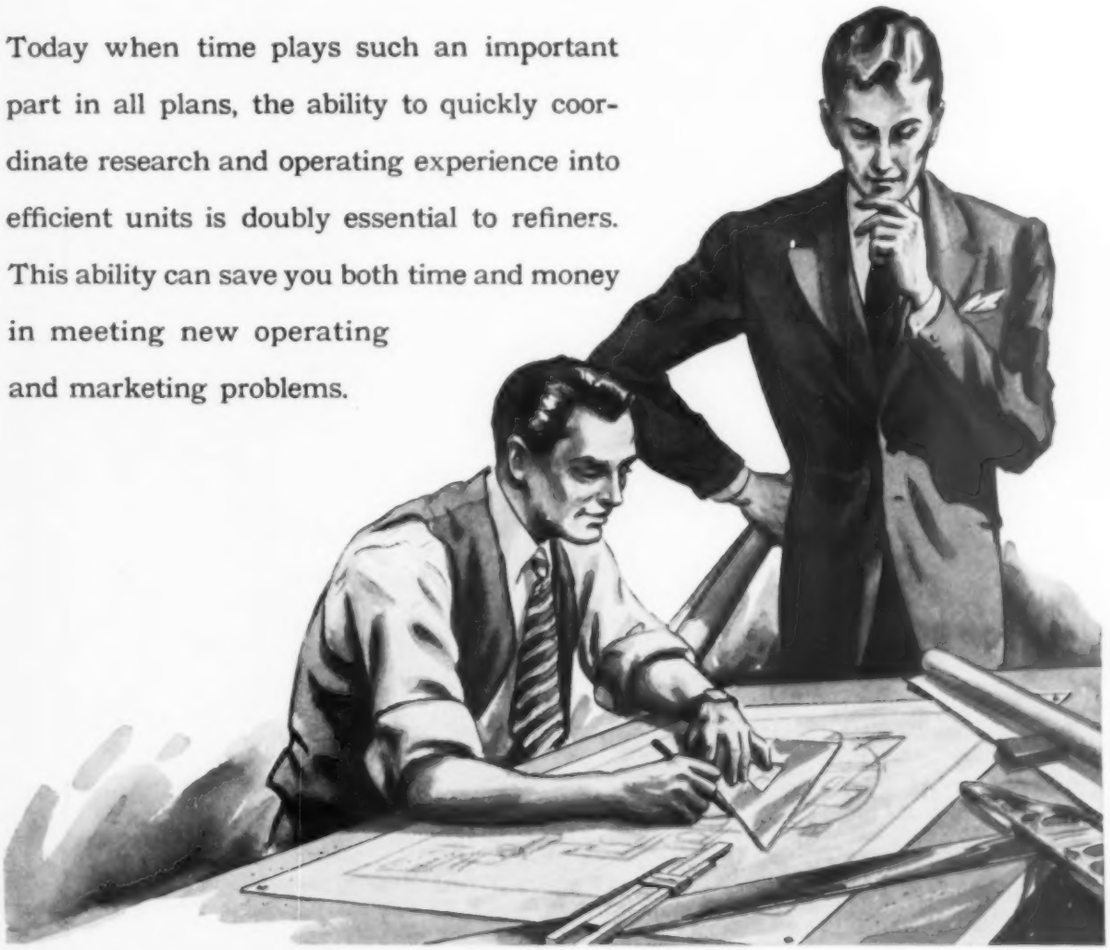
Today when time plays such an important part in all plans, the ability to quickly coordinate research and operating experience into efficient units is doubly essential to refiners. This ability can save you both time and money in meeting new operating and marketing problems.



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LIMITED

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The invisible GUARANTEE IS THE DETERMINATION OF GULF TO MAKE THE BEST PETROLEUM PRODUCTS THAT SKILL, SCIENCE, LOYAL EMPLOYEES AND ALERT MANAGEMENT CAN JOINTLY ACHIEVE.

WHICH OF THESE *Airetool Products* DO YOU NEED?

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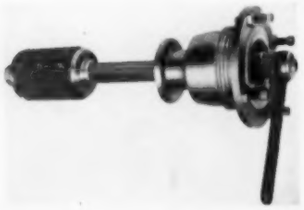
FLYCUTTER

Valuable for machining end of tube after rolling; for securing a welding groove to seal weld the tube to the header and for removing a Bad tube without burning it out. Flycutter can be adjusted to exact position required by simply loosening screws in the set collar held in position by the housing. No loose spacing collars.



TUBE JIG

Alloy tubes and headers meant discontinuing the old method of tack welding or wedging the tube to the header during the rolling operation. Tube jigs are needed to hold tubes and headers in position and alignment.

FOR INSPECTION

CALIPERS

For checking I.D. of tube ends and the thicknesses of headers, fitting walls and valve bodies. Simple, lasting construction. Easily checked and adjusted.

the newest...

TUBE EXPANDERS

Type G-100

As oil refinery technology advances, the demand for higher temperatures and pressures makes it essential that all joints be properly rolled.

Airetool Tube Expanders are constructed in such a manner as to insure perfect joints between tubes and headers. Cage and mandrel stops on the tools are quickly and accurately set for proper rolling depths and flare.

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AIRETOOL CATALYST REMOVAL SYSTEM

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FOR MAINTENANCE

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For polishing or grinding ends of tubes. Polishing or grinding wheel may be of an inflated or emery type, depending on the service for which it is required.

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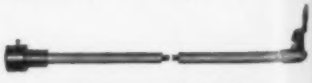
Available for various header types. Should be used during cleaning or rolling operations, or any other operation that requires passing a tool through the header.



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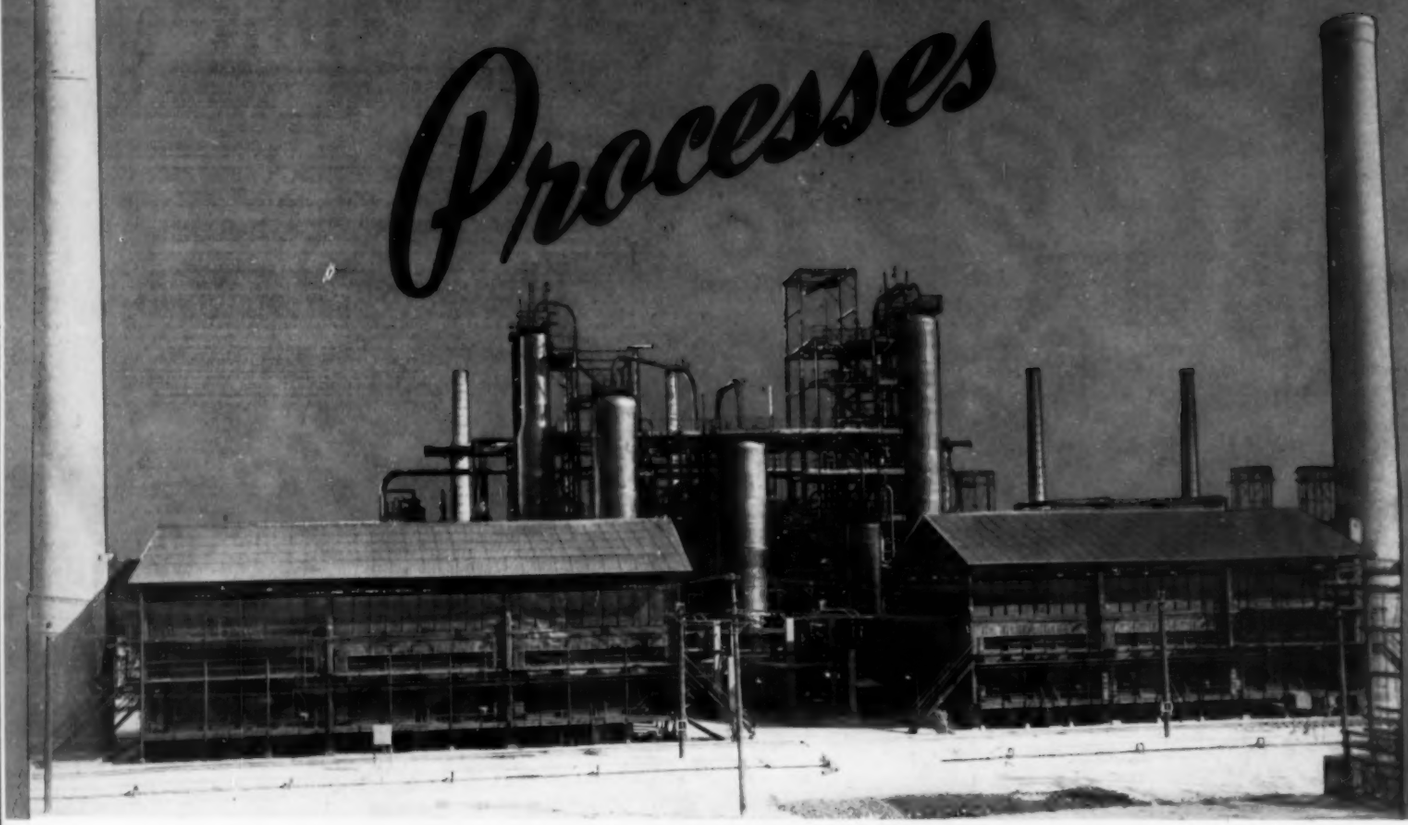
Research Octane of from 85 to 95.
A spread between the CFR-ASTM and research octane of from 9 to 14 numbers . . . between CFR-ASTM and road octane of 3 to 8 numbers . . . depending on feed stock and operation.
High Overall yields.
and
TOLUOL
you can get all these with...

THE POLYFORM AND GAS REVERSION *Processes*



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When applied to gas oils or reduced crudes, it is possible to get conversions per pass approximately double those obtained by conventional cracking. Full crudes may be selectively cracked. Non-residuum full coking operations may be obtained, if desired.

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LUMMUS

PETROLEUM REFINING PLANTS

APR 30 1941
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WORLD PETROLEUM

Founded by Russell Palmer

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VOLUME 12 | MARCH, 1941 | NUMBER 3

WORLD PETROLEUM: Incorporating Petroleum Equipment Exporter

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America's defense effort gets under way: night view of the first toluene plant completed in the United States for the Shell Company at Houston, Texas. Front cover picture shows one of the highly efficient recycling plants that contribute so effectively to conservation.

EDITORIAL

BROADER SERVICE FOR THE INTERSTATE COMPACT

WITHOUT fanfare, and keeping carefully within the limitations set for it by Congress, the Interstate Compact Commission is moving along practical lines to promote greater unity and efficiency in the work of oil producing states for conservation of petroleum resources. This is a movement capable of great service if it can enlist the support and cooperation of the various organizations representing the members of the oil industry and of the legislators and other officials of states whose rights and revenues may be extinguished by the extension of federal control to embrace all parts of the oil business.

In the February number of World Petroleum Judge J. C. Hunter, president of the Mid-Continent Oil and Gas Association, who has been closely associated with the activities of the Compact Commission, outlined the ways in which it could extend its influence and accomplish results of great value without any broadening of its very limited legal authority. In this issue the stirring and instructive address delivered by George A. Hill, Jr., president of the Houston Oil Company, at Shreveport, La. on February 28, points the need of active support for the plans of the Commission as a possible means of avoiding the danger that seriously threatens the oil industry.

Because of the very fact that the Compact is essentially a voluntary association, because it has no authority to impinge upon the freedom of action of any adhering state, and because it can have no other objective than the good of the industry as a whole, the Compact Commission is in an excellent position to exert a strong influence toward extending and improving state regulation and securing its acceptance in states where it is not now in effect. It can do this, as it is doing now, by enlisting the best engineering talent in determining sound and equitable methods of proration. It can, as it is doing now, study existing state laws and prepare a measure which covers the essential points of an effective law while leaving it to the various state legislatures to state these requirements as they see fit. It can make known the advantages of a carefully guarded system of local regulation to every member of the oil industry from smallest to largest and to the public that the industry serves. It can act as a forum for the discussion of new ideas and methods of promoting sound conservation which then will stand or fall according to their merit.

All this and more the Compact Commission can do for the very reason that it has no administrative duties to perform and no police powers to exercise. But it can accomplish results only with broad support from the oil producing states and the oil industry. As Russell B. Brown of the Independent Petroleum Association in a recent utterance described the sound policy to be followed it is "for the industry and the states concerned with petroleum production to occupy the field of conservation so completely and so satisfactorily as to make unnecessary any elaborate scheme of federal control". To the attainment of that end the Interstate Compact Commission can and should direct its efforts without abandonment of its present functions and without enlargement of its powers.

It is among the proper functions of the individual state to see that its resources are not misused, that the rights of individual citizens are not impaired or destroyed by the actions of others and that no member of the community is allowed to take an unfair advantage of his neighbor. The application to the oil industry of such local regulation, soundly based and fairly administered, represents the exercise in the economic realm of the same sort of police power that is used to preserve order or to prevent the loss of life and property through fire or other hazards. It is a limitation on individual freedom of action that is accepted as being in the common interest. It remains close to the people and can be changed by them if it is abused or fails to work as intended. There is a world of difference between it and the control of business operations by a bureaucratic organization so far removed from the reach of ordinary citizens that they are defenseless against its actions.

Interstate Oil Compact As an Instrument of DEMOCRACY

By George A. Hill, Jr.

President of the Houston Oil Company

Explains the Origin, Purposes and Achievements of the Compact Which May Someday Avert the Catastrophe of Federal Control, in a Paper Delivered Before the Southwestern Division of Production of the A.P.I.

WE are in the midst of a world struggle for survival of Totalitarianism against Democracy and we are entered in the lists as the defenders of a besieged and embattled Democracy.

It is well that we pause now, lest we be too late, to consider the means by which we may best contribute to the defense of our Constitutional Democracy, not only with physical and material support, which we are superbly able, willing, and qualified to give as volunteers, but also in strengthening, shielding, and fortifying the processes of Democracy in order to effect the salvation of our American way of life.

Totalitarianism is not always accomplished by the bold, open and brutal seizure of total power and merciless dominion. It may be achieved alike by the continuing surrender of a people's sovereignty and by gnawing encroachments upon personal liberties until Dictatorship suddenly emerges from the sawdust of Democracy.

Therefore we must examine, and then reexamine, recurrent assaults upon our American fundamentals, as we go our daily way, to safeguard the liberties we now possess lest we lose them in the mere preparation for their supposedly better defense.

We should be supremely wary, as an industry, of yielding to the opportunistic temptation (spoon-fed out of the syrupy cup of claimed emergent necessity) of surrendering an existing Democratic process for a dictatorial and authoritarian federal control, on the chance of later and ultimate resumption of the Democratic process when and if an eager federal bureaucracy wearies of the exercise of plenary power.

Is then, the Interstate Oil Compact Commission a worthy instrument of Democracy and do its achievements entitle it to continued life as a public servitor?

ORIGIN

The first interstate compact in the history of the United States was entered into between the states of Virginia and Kentucky in 1789 (over 150 years ago) and made provision for the determination of rights and interests in lands severed from Virginia and jurisdiction over the Ohio River. Throughout the succeeding years, many and diverse compacts were entered into between various states and combinations of states, and the principle of state collaboration, cooperation, and consultation has become deeply embedded in our constitutional system as a useful and normal process of effectuating a common and kindred policy in keeping with the spirit of our Constitutional Democracy.

The solution of the early difficulties of the oil industry received the careful thought and studious consideration of many able men, both within and without the industry, Dr. Ray Lyman Wilbur, one-time Secretary of the Interior and Chairman of the Federal Oil Conservation Board (which was purely advisory) was one of the early proponents of an interstate oil compact between the oil producing states, safeguarding conservation. He recommended that the federal government supplement such agency with appropriate regulation of the importation of oil and its products since this matter lies within the exclusive jurisdiction of the federal government. Many individuals, oil and gas associations, governors, members of oil regulatory commissions, and others subsequently gave public expression of their approval of the proposal that an interstate oil compact be entered into between the several oil producing states with the following eventual result: In Dallas, Texas, on the 16th day of February, 1935, an interstate compact to conserve oil and gas was executed by the representatives of the states of Oklahoma, Texas, California, and New Mexico, and thereafter recommended for ratification by the representatives of the states of Arkansas, Colorado, Illinois, Kansas, and Michigan. Subsequently the compact was ratified by the states of Arkansas, Colorado, Illinois, Kansas, Michigan, New Mexico, Oklahoma, and Texas, and bills are now pending in a number of other states seeking authority to become members of the compact.

The following purposes are quoted from the Compact Act itself:

PURPOSES

"The purpose of this compact is to conserve oil and gas by the prevention of physical waste thereof from any cause.

"Each state bound hereby agrees that within a reasonable time it will enact laws, or if laws have been enacted, then it agrees to continue the same in force, to accomplish within reasonable limits the prevention of:

"(a) The operation of any oil well with an inefficient gas-oil ratio.

"(b) The drowning with water of any stratum capable of producing oil or gas, or both oil and gas in paying quantities.

"(c) The avoidable escape into the open air or the wasteful burning of gas from a natural-gas well.

"(d) The creation of unnecessary fire hazards.

"(e) The drilling, equipping, locating, spacing, or operating of a well or wells so as to bring about physical waste of oil or gas or loss in the ultimate recovery thereof.

"(f) The inefficient, excessive, or improper use of the reservoir energy in producing any well.

"The enumeration of the foregoing subjects shall not limit the scope of the authority of any State.

"Each state bound hereby agrees that it will, within a reasonable time, enact statutes, or if such statutes have been enacted then that it will continue the same in force, providing in effect that oil produced in violation of its valid oil or gas-conservation statutes or any valid rule, order, or regulation promulgated thereunder, shall be denied access to commerce; and providing for stringent penalties for the waste of either oil or gas.

"It is not the purpose of this compact to authorize the states joining herein to limit the production of oil or gas for the purpose of stabilizing or fixing the price thereof, or to create or perpetuate monopoly, or to promote regimentation, but is limited to the purpose of conserving oil and gas and preventing the avoidable waste thereof within reasonable limitations.

"The Commission shall have power to recommend the coordination of the exercise of the police powers of the several states within their several jurisdictions to promote the maximum ultimate recovery from the petroleum reserves of said states, and to recommend measures for the maximum ultimate recovery of oil and gas. Said Commission shall organize and adopt suitable

rules and regulations for the conduct of its business.

"No state by joining herein shall become financially obligated to any other state, nor shall the breach of the terms hereof by any state subject such state to financial responsibility to the other states joining herein."

ACHIEVEMENTS

The Compact Commission has proceeded to discharge its advisory functions along the general lines set forth below:

(1) Mimeographing and distribution of reports of its quarterly meetings;

(2) Compilation, printing and distribution of the laws, rules, and regulations of the regulatory commissions in the several oil producing states;

(3) Preparation and distribution of model conservation act;

(4) Educational work along conservation lines, and the holding of meetings in oil-producing states, not members of the Compact;

(5) Unofficial participation in meetings by representatives of non-member states;

(6) Providing periodical forum for reports and papers by eminent technicians in the industry from the oil regulatory commissions and from federal and state agencies;

(7) Distribution of maps, charts, reports and papers;

(8) Studies and reports by special committees;

(9) Engineering Committee now engaged in preparation of a handbook of approved engineering practices in oil production;

(10) Compact representatives attend meetings of state regulatory commissions as observers;

(11) Compact representatives attend and participate in various national and regional meetings of oil and gas associations where the problems of conservation are under study and investigation;

(12) The Compact Commission makes recommendations concerning the conservation of oil and gas to the oil-producing states.

The Compact Commission is a consultative and advisory body that resorts only to reason and persuasion and not to coercion and compulsion. This can well be illustrated by the personnel of, and the mission upon which, its Engineering Committee is now engaged.

Its personnel is as follows:

E. De Golyer, Dallas, Texas, formerly President of the Amerada Petroleum Corp., Past President of the American Association of Petroleum Geologists, and of the American Institute of Mining and Metallurgical Engineers, and former Professor of Geology at the University of Texas.

Eugene A. Stevenson, Lawrence, Kansas, formerly with the United States Geological Survey, now Professor of Petroleum Engineering at the University of Kansas.

F. M. Van Tuyl, Golden, Colorado, Professor of Geology and Mineralogy at the Colorado School of Mines.

Less S. Miller, of the Conservation Department of the State of Michigan.

W. C. Harson, Norman, Oklahoma, Dean of the School of Engineering at the University of Oklahoma.

A. Andreas, Santa Fe, New Mexico, State Geologist of New Mexico.

The mission of this committee is the preparation of a handbook of approved engineering practices in oil production. The handbook that will result from such study and report will undoubtedly be of great value to the Compact Commission, to the oil industry, to the oil-producing states, and to the nation.

I believe that the following conclusions are deducible from the facts hereinbefore recited, and from what is now painful public knowledge.

Totalitarianism is, in its essence, based upon:

(1) Centralization of control;

(2) Subjection to government regimentation;

(3) Elimination of private initiative and capital;

(4) Resort to compulsory and coercive processes;

(5) Destruction of our constitutional system of a dual state and federal system and

(6) Merger of the separate legislative, judicial and executive functions into one all-powerful and dictatorial administration under the leader-principle, as exemplified in the Nazi, Facist, and Stalinist ideology.

Under the Democratic process, we respect:

(1) Our constitutional Democratic system;

(2) The integrity of our states;

(3) The cooperation of the several states on common problems with the consent of Congress;

(4) Individual liberties as guaranteed under the bill of rights;

(5) Private initiative, capital and enterprise;

(6) Resort to reason and cooperation instead of dictation and compulsion; and

(7) Prevention of the unnatural concentration of power in central government which is already overburdened with administrative responsibilities and powers, the excess of which tends to weaken and undermine the effective discharge of its natural and exclusive federal functions.

Compacts or agreements between states may be made and enforced when approved by Congress. The federal Constitution so provides. This method has been employed most frequently for the purpose of disposing of some fact problem, such as a boundary question or the use of navigable waters or the diversion and use of water rights common to two or more states.

It is not possible, however, for a group of states to join together under this plan for the purpose of reposing in the majority members the power to direct or control the general legislative authority of any soveriegn member state. Only the federal Congress has this power. Even there it is limited by the Constitution.

This distinction is now realized by many who formerly charged that the Interstate Oil Compact Commission was without power to act; that the articles of agreement had no teeth and could not compel performance by the states.

Too much stress cannot be laid upon the fact that the only agreement in the Compact having binding effect on the member states is the commitment by each member to have statutes providing for the conservation of oil and gas. It is not required that these statutes be identical or even similar. Each state is to solve its own problem in that respect. Some of the states having a substantial wealth of oil and gas have hesitated to become members of the Interstate Oil Compact Commission for fear of some encroachment by the Commission upon their sovereignty. They have not been able to forget the early discussions where many strong voices contended the Compact should be clothed with broad power to compel performance by the member states of edicts of the Commission, a power which fortunately we now all agree could never exist.

One of the oil states which has hesitated to become a member of this body is the state of Louisiana. Yet it has complied with the only obligation which would be imposed upon it by the Interstate Oil Compact agreement. It has a conservation statute.

This statute is not patterned after the policy of the laws of other states; it is dissimilar in many respects. Yet in my humble judgment it has taken a long and realistic step toward the fulfillment of the only justifiable objective of any conservation statute, namely, the recovery from their natural reservoirs and utilization of the greatest amount of these minerals in a manner to make them available to the public at the lowest cost. The spacing and production program of the statutes of Louisiana seeks to eliminate unnecessary drilling without destroying property rights. The operator in Louisiana is able to bring the oil to the surface at a lower lifting cost because of a well planned elimination of useless and wasteful drilling duplication. He can pay the heavy tax burden and still make money because the state has made it possible by this method to produce its oil cheaper than other states. This is the acme of true conservation because low production cost delays abandonment, thereby increasing recovery. The consumer and the state must ultimately benefit from this program. Louisiana is to be commended for this statesmanlike accomplishment.

The Interstate Oil Compact Commission needs the cooperation and counsel of states like Louisiana which is boldly meeting the industry's problems. These states need the Compact. It is performing a true service as the great exchange, the open forum, where the intricate difficulties of conducting a great industry are examined; where ideas, ideals and solutions are exchanged and studied; from which may come recommendations, recommendations which each member state is perfectly free to accept or reject according to its own best interests.

Those who conduct and participate in this great parliament, whose edict is enforceable only by the mandate of reason and sound judgment, are public officials, men whose essential duty it is to find for the public the best way to recover as needed from nature's storehouse, unwasted, the maximum of this priceless mineral wealth at the minimum cost to the consuming public for whom these officers are the trustees.

A speaker before the Compact Commission on one occasion compared this function of the Compact Commission to the function of the catalyst in the refining process of petroleum. The most common and most remarkable of all the catalysts is chlorophyll, the greencoloring matter found in all vegetation, whose endless miracle has created from the sun's rays and the elements of the earth, by miraculous and unexplained change, the hydrocarbons, and stored them in the earth for the use of man. This miraculous worker, the catalyst, remains unchanged but the substances which come within the scope of its influence take on new forms. In speaking he said: "We come together as discordant and unsimilar elements, tied tightly around our local problems, and in the presence of the catalyst, the psychology of human contact and human relation, we go away from these meetings with an understanding and with a viewpoint that has converted the localized and individual problem into its proper relation in the national picture. The fact that it is difficult to take apart and explain the function that has been performed, the fact that it has not been clearly understood and has not been analyzed has largely caused observers to fail to comprehend fully the importance of this function."

I earnestly renew again to all of the oil producing states, and especially to the statesmen of Louisiana who have made such constructive advance, the invitation so frequently extended, to become members of the Interstate Compact Commission. There can be no infringement of your sovereignty. Only the compulsion of your own judgment can enforce its recommendations. You can help to make it function more successfully; it may be of inestimable value to you at a time when the democratic structure of our government is imperiled from without and within. This body may enable the miracle performance of the catalyst in bringing into existence a new vehicle of liberty and local self-government coordinated with national welfare; it may avert the catastrophe of centralized regimentation of Federal oil control.

WAR PROBLEMS Claim Attention of Petroleum Division of Mining Institute

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Humble's Vice president, John R. Suman, President of American Institute of Mining and Metallurgical Engineers—War in Relation to Supplies, Transportation Attracts Principal Interest.

THE Annual Meeting of the American Institute of Mining and Metallurgical Engineers was held in New York, February 17 through 20. Meetings of the Petroleum Division, one of several comprising the AIME began on Tuesday, February 18 and lasted three days being concluded by a dinner at the Hotel Biltmore on Thursday evening, February 20. In addition to the excellent papers presented to the Petroleum Division, this meeting of the AIME was particularly interesting to the oil industry because of the election of John R. Suman, vice-president and director of Humble Oil & Refining Company as president of the Mining Institute.

The first day's meeting of the Petroleum Division was devoted to general engineering papers. These indicated a steady progress in perfecting and developing techniques already in use by the industry. C. P. Parsons, vice-president, Halliburton Oil Well Cementing Company, described in some detail steps that had been taken to put oil well cementing on an exact and scientific basis as contrasted to its earlier rather loose application. No new geophysical prospecting methods were revealed at this meeting although refinements in the art were discussed in several papers and a relatively new form of geochemical well logging was described by Leo Horvitz of Subterrex. Development of new techniques in exploration are eagerly awaited by the industry, but as yet work along this line is confined to perfecting methods already in use.

On Wednesday, February 19, the second day of the Petroleum Division meetings a number of papers on production in foreign and domestic fields were presented. The papers on production in foreign fields were limited and dealt with only a few countries due to the almost complete lack of data on areas involved in the European war.

James Terry Duce, in discussing the effect of the war on the petroleum industry outside the United States emphasized two interesting conclusions: (1) petroleum reserves, except those actually in storage and readily accessible, are of little importance once a country is actually involved in hostilities. Shortages of steel, skilled labor and equipment of all kinds make undeveloped reserves inaccessible except at a heavy price in manufacture of munitions and other wartime essentials. (2) a national refining system without indigenous crude supplies is of no military importance and, in fact, the money that was required to build up such national refining facilities might better have been spent in building storage and maintaining stocks of petroleum products. It is interesting to note that as long ago as December 1935, WORLD PETROLEUM, in discussing the activities of European nations in the face of threats arising from Italy's Ethiopian adventure, under the heading "Security of Oil Supplies in Wartime" said:

> "But the present situation exhibits the fallacy of the argument that the establishment of refining facilities will add to the security of a non-producing country in time of war or other emergency. Actually the contrary is the case and the nation without crude supplies within its own borders is handicapped in meeting such emergencies if it depends upon the importation of crude supplies rather than of finished products."

At the morning session devoted to papers on production abroad, the point was made that Australia was enjoying considerable exploratory activity, due mainly to modif-

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Above, Eugene Halman, principal speaker at Petroleum Division dinner, and right, James Terry Duce, who spoke on oil production abroad.

ication of the laws in that country that barred large scale effort prior to 1939. Shell, California-Texas and Superior of California have taken up large areas in Queensland. Jersey Standard, Anglo-Iranian and Oil Search (an Australian company) have been active through the work of Australasian Petroleum Company Proprietary Ltd. Indications now are that the oil possibilities of Australia will be thoroughly tested in the near future.

In Canada, the outstanding feature of 1940 was the discovery by Standard of British Columbia's Princess No. 2 of a new field in the Stevéville area 100 miles east of Calgary. Production in Canada has increased substantially during the past year and prospects are for a continued increase in the immediate future.

Activity in Peru followed the pattern laid down during the past several years. Production was off by about 10 percent due to loss of markets resulting from the war, drilling activity increased somewhat during the past year and the Peruvian government set aside a large additional national reserve near the Ganzo Azul production in Eastern Peru. In Ecuador, exploratory work went forward on schedule on the huge concessions obtained recently by Shell and International Petroleum Company.

The net impression from the foreign session was that exploration, at least so far as it was in the hands of major units of the international industry, continued active looking toward eventual stability in international petroleum affairs and a greatly increased demand for products; but actual production has suffered through loss of markets resulting from the war in Europe and Asia.

Domestic papers revealed that the country as a whole might be approaching the end of an active cycle of new discoveries and should witness some change or modification in exploration practice before the rate of discoveries will again reach the levels set by the last few years. In the east, activity was affected by the drop in prices for lubricating oil stocks. Production in New York state was off slightly due to the decline in prices and while drilling was active in the water flood areas, it might be assumed that production rates would remain down until prices recovered substantially. The year's production was up slightly in Pennsylvania due almost entirely to development of the Music Mountain field discovered in 1937. Drilling activity in Bradford showed an increase reflecting the hopes of operators for improved conditions in the near future. In Tennessee both drilling and production declined slightly in 1940, but there are definite possibilities that development in the western part of the state may lead to increased activity during the future. In West Virginia production decreased slightly, proved reserves were estimated to be slightly less than a year ago and oil activity in general suffered from the unfavorable price situation. In Ohio and Indiana activity showed a slight increase, but there were no important discoveries in either area. In both states there was a considerable increase in the amount of drilling.

In Michigan no major developments marked 1940 but several important wildcat tests were scheduled for 1941 and it is expected that results will be more interesting during the present year. In Mississippi, Missouri, Louisiana and Arkansas the year's results were about the same: more drilling, but either a decrease in production or only a slight increase at best.

In Oklahoma the industry followed routine development with production off somewhat, the discovery of new wells showing a slight decline and such discoveries as were recorded being of minor importance. Wildcat drilling, however, increased by 20 percent compared with the preceding year. In Texas there was a more active leasing campaign than in recent years, but with the exception of the Hawkins field in Wood County, East Texas, there were no unusually important fields discovered. Several new sands were tested successfully in various parts of the state, which may be the most important development of the past year for those localities. Off-shore drilling continued with reasonable results. In general there was more wildcat drilling and the industry looked to the coming year for a more successful exploration campaign.

California also saw more wildcatting in 1940 than in 1939, but recorded no major discovery. The suggestion was advanced that California was reaching the end of a highly successful cycle of exploration. During the year just past construction was commenced on the first recycling plant for that state. While the Japanese market was lost to California exports during 1940, it was suggested that at least a part of this loss of export market would be made up by increased shipments to other markets in the Pacific, and that a much greater market would develop domestically as a result of industrial activity in California growing out of national defense efforts. The question was raised in connection with this paper if shipments to the Philippines had not increased in some measure as shipments to Japan declined; and if the Philippines were not simply serving as a point of trans-shipment for petroleum products going to Japan.

Wednesday evening the regular banquet of the entire Institute was held in the Grand Ballroom of the Hotel Commodore. John R. Suman, vice president and director of the Humble Oil & Refining Company, the new president of the AIME succeeding Herbert G. Moulton, was introduced at a reception following the banquet. Mr. Suman, who has been a construction engineer, mining engineer, geologist, and who is thoroughly familar with the latest developments in petroleum drilling technology, was born in Indiana and raised in California where he received a degree from the University of California at Berkeley. During the banquet he spoke briefly on the place of the engineer in the national defense effort.

At the banquet the Anthony F. Lucas medal was presented to Conrad and Marcel Schlumberger for " . . . distinguished achievement in improving the technique of finding and producing petroleum." The medal was received by Mrs. H. G. Doll, daughter of the late Conrad Schlumberger who died in 1936. Marcel Schlumberger is now residing in Paris.

The following day (Thursday, February 20) the Petroleum Division devoted its attention to several important economic papers. E. De Golyer's paper summed up the conclusions that might have been drawn from the domestic production and engineering

sessions; that exploration techniques now in general use were approaching the end of their cycle of greatest utility. Reflection seismograph would, of course, be used for many years to come; there remain large areas that required closer study by this method; geochemical exploration was in a sense a new tool, but all indications are that the industry will have to revert to straight wildcat drilling unless a radically new geophysical technique makes its appearance soon. De Golyer suggested that the industry would rely to an increasing extent on drilling, but would confine this as far as possible to inexpensive slim hole drilling for exploration only and that it would have to rely somewhat more on geological reconnaissance with geophysical methods, mainly for checking. In the discussion that followed this paper, De Golyer refused to commit himself on the outlook for discoveries; chance played too large a role in this aspect of the problem to make predictions of any value.

John D. Gill raised the question of how much waste would actually have been avoided had the petroleum resources of the United States been developed under government control. In an able exposition of the place of competition in a natural resource industry, Gill made it clear how greatly reduced would have been the benefits that had accrued to the national economy from the rapid competitive development of the petroleum industry under private initiative, had the direction of the industry been under government control.

Emby Kaye, Distillate Engineering and Process Company, delivered a paper on one of the industry's outstanding efforts toward sound conservation: the use of recycling in distillate fields. Kaye's paper dealt mainly with the economic aspects of this relatively new but extremely important subject.

V. R. Garfias and R. V. Whetsel, Cities Service Company, delivered papers on world production and consumption of crude petroleum and petroleum substitutes. Including natural gasoline, it was pointed out that the world's production of substitutes was equal to the crude oil production of Mexico, Colombia and Roumania, that the war had greatly stimulated the production and use of substitutes, and that the United States led the world in production of crude petroleum substitutes, since natural gasoline was included under this classification. Garfias and Whetsel estimated that world consumption of petroleum and products, exclusive of military demands, had decreased in 1940 by 21 million barrels from the estimate for 1939.

W. B. Case, Shell Oil Company, discussed the role of residual fuel oil in the petroleum industry, covering approximately the same ground as was reviewed in the article on defense requirements of residual fuel oil in the February issue of WORLD PETROLEUM.

B. Orchard Lisle, consulting petroleum technologist, discussed the tendency to underestimate supplies of liquid fuel available to Germany. Lisle presented estimates of quantities available to Germany from various sources, including production of synthetic products, crude oil production in Germany and in the states that are controlled by German armies, and the quantities that might reasonably be assumed to be imported from Russia and Roumania. The paper gave rise to considerable discussion, centering largely around the last mentioned sources and the availability of transportation for the quantity of oil available from Russia and Roumania. The point that Germany is not nearly as badly off in regard to liquid fuel supplies as had been assumed earlier in the war, was, however, clearly established.

Thursday, the usual banquet of the Petroleum Division was held at the Biltmore. Dr. Eugene A. Stephenson, professor of Petroleum Engineering at the University of Kansas was introduced as chairman of the Petroleum Division for 1941. Eugene Holman, Standard Oil Company (N. J.) spoke on the importance of transportation in a world at war and made the point that on a ton-mile basis tanker transportation was by far the most important and was also subject to the greatest readjustment as a result of warfare. Transportation of Russian and Roumanian oil into Germany presented a major problem for that country and one for which no adequate solution had probably been found, at least in the case of Russia; the solution of the problem of transporting Roumanian oil was rapidly being overcome, partly by the construction of pipelines and partly by the introduction of tank cars from other parts of continental Europe. Italy's dependence on tanker transportation has resulted in her having to rely almost entirely on stocks accumulated prior to the war. Japan, being a non-belligerent, has experienced more difficulties in obtaining supplies than in transporting them. Should her status change, however, Japan would have a serious problem of transporting petroleum required for the prosecution of a war. Great Britain is one of the countries most affected by readjustments of tanker transportation. The shorter Mediterranean route from Iran and Iraq has been at least partially closed, and the necessity for the use of convoys has further reduced the effectiveness of the British tanker fleet which, with the additions obtained from Norway, Holland and others, comprises roughly half the world's tanker tonnage. The greater time required plus the dock damage and tanker sinkings has probably brought British tanker balance comparatively close. In the United States a number of factors have contributed to tightness in the tanker market: construction, repairs, use of alternative means of transport, and smoothing out seasonal peaks is necessary to relieve this condition.

EASTERN VENEZUELA'S Promising New Fields

Santa Barbara No. 1, Discovery Well of Venezuela Petroleum, Flows 4,000 Bbl. From Hundred Foot Oil Sand — Santa Rosa Proves Important Addition to Mene Grande's Production.

WHILE wartime conditions, by circumscribing export markets, have slowed down Venezuelan crude production to a certain extent in recent months they have acted as no deterrent to exploratory work which is being pushed with particular activity in the eastern areas. Fresh interest in fact has been stimulated in this territory by important recent discoveries. As a result of these discoveries development activities in certain new fields will be intensified and plans for wildcatting on concessions not yet tested are going forward.

Irrespective of temporary limitations it is realized that Venezuela's strategic situation in relation to markets on both sides of the Atlantic makes it practically certain that its oil will find ready markets when trade returns to a normal peacetime basis. Oil men generally are agreed that the end of the war will be followed by an unprecedented demand for petroleum products and that the development of new fields now is a logical step in anticipation of future needs.

Most spectacular of recent discoveries and consequently the one that has created the most discussion was the bringing in of Santa Barbara No. 1 early in February.

Flowing at an estimated rate of 4,000 bbl. a day of 29 gravity oil on Halliburton test, Santa Barbara No. 1 of Venezuela Petroleum Company placed that company definitely in the ranks of active Venezuelan producers. News of the discovery caused shares of the

company to advance from 37½ cents to $3.00 practically overnight on the New York market and brought the following statement from Harry F. Sinclair, chairman of the executive committee of Consolidated Oil Corporation of which Venezuela Petroleum is a subsidiary:

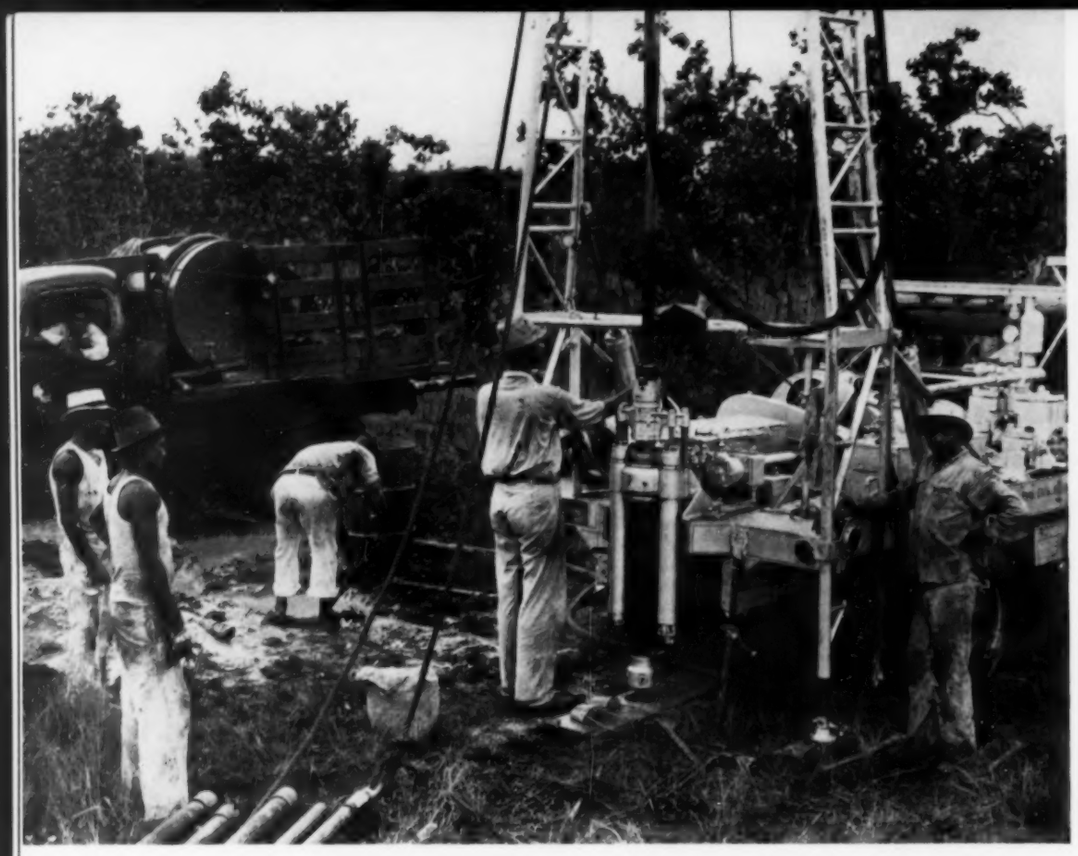
"The most important development made by Consolidated Oil Corporation for many years is the discovery by its subsidiary, Venezuelan Petroleum Co. of its first oil well in the State of Monagas, Venezuela. Venezuelan Petroleum Co. has been conducting extensive exploratory and geophysical work in Venezuela for a number of years and has under lease in various areas nearly one million acres, selected after thorough scientific investigation.

"This new field should place Consolidated Oil Corporation on a competitive basis with the now three dominant producers in Venezuela—Standard Oil of New Jersey, Gulf, and Dutch Shell giving Consolidated the same advantage of cheap production with important tax reductions under the present trade agreement between the United States and Venezuela.

"The recent discovery well, designated as Santa Barbara No. 1, the town of that name being the nearest settlement to the location of the well, is on a lease of approximately 25,000 acres ten miles from the Jusepin field. At the last report it was 87 ft. in producing sand. When the test was made the well flowed at the rate of 4,000 bbl. per day. This showing makes the well one of the outstanding producers since oil was discovered in Venezuela."

Santa Barbara No. 1 of the Venezuelan Petroleum Company (Consolidated) pictured above, came in for 4,000 bbl. per day in February.

As stated by Mr. Sinclair the discovery is located in the state of Monagas near the town of Santa Barbara, in a block of 25,000 acres which forms part of the extensive holdings of Venezuela Petroleum in that state. It is slightly southwest of Jusepin in the general direction of the Oficina field of Mene Grande Oil Company and is directly in the line of the trend that geologists have defined



Light portable rig operating with seismograph party near the Jusepin field late in 1940.

as extending from Trinidad southwesterly across the eastern part of Venezuela.

Prior to selection of the drilling site the area was thoroughly surveyed by geophysical methods including use of the seismograph, torsion balance, gravimeter and soil analysis. According to A. E. Watts, chairman of Venezuela Petroleum Company, the soil analysis conducted by Geophysical Scientific Service Co was very helpful in leading to the successful location of the well.

Santa Barbara No. 1 was the first well to be drilled in eastern Venezuela by the Company. It was spudded in December 28, 1940, using a fairly heavy rotary rig capable of drilling to a depth of 7,000 to 8,000 ft. The drilling was done by a company crew and included the use of a special method of mud treatment developed by the company. An unusual incident in putting down the well occurred when thick strata of sand and gravel encountered at 350 ft. produced a large flow of fresh water capable of providing a good water supply.

At 4,158 ft. the drill met an oil sand which extended unbroken for approximately 100 ft. Below this some shale strata were found and the drill was stopped at 4,320 ft. The drilling was completed with a 2,500 lb. mud pressure and the bottom hole pressure was 2,000 lb. The drilling was carried out without any difficulties or unusual delays. Actual drilling time was approximately thirty days, most of the remaining period being spent in taking cores for analysis as the work progressed.

The first 100 ft. of the well was set with 16½ inch casing, the next 1,000-ft. with 10½ inch and the well was finished with a 7-inch hole. In character the oil sand in the Santa Barbara well resembles the upper sands of the Jusepin field and the relative elevation suggests the possibility that deeper drilling might uncover a formation duplicating the main sands of the Jusepin field. In view of the very satisfactory showing of the wall just brought in, however, no attempt is being made to go deeper in this instance.

The company intends to proceed with additional drilling and as soon as sufficient production is developed a pipeline will be laid extending westward from the field a distance of 55 miles to a point north of El Roble near the Mene Grande pipeline and thence northward paralleling the Mene Grande line to Guanta on the Caribbean coast, a further distance of 50 miles. Near Guanta the Venezuelan Petroleum Company already owns an extensive shorefront site on which a terminal will be constructed for trans-shipment of the oil to tankers.

Discovery of a substantial source of crude supply in Venezuela fits very fortunately into the expansion program which Consolidated Oil Company has under way. The company has need for additional crude to feed its refineries and has under construction a fleet of tankers that can be used in part for movement of the oil.

In addition to its holdings in Monagas the Venezuela Petroleum Company has extensive exploratory concessions in the state of Barinas and Apure in the undeveloped area of western Venezuela but no drilling has been done in these areas as yet.

Indications of another important new field of high gravity oil in Eastern Venezuela are given by Santa Rosa No. 2 well, recently brought in by the Mene Grande Oil Company S. A. in territory located a few miles to the east of its 16-in. pipeline and about 60 miles nearer to the deep water terminal at Puerto La Cruz than the Oficina field.

The new field is part of a series of dome structures, four of which are already known to be oil bearing, extending approximately 30 miles northeast from Santa Ana and about three miles in width. This is known as the Santa Ana-San Joaquin-El Roble-Santa Rosa area. Altogether there are 19 producing wells in this group of fields up to the present time. The deepest is 10,197 ft. and the shallowest 5,668 ft. At Santa Ana two wells were completed up to April, 1940, and another is now being drilled, work being held up temporarily by a fishing job. At San Joaquin there are 14 wells on a 20-mile by three mile area. These fields are connected to the Mene Grande pipeline by branch lines. Just outside the borders of this area there are a few tested wildcat wells. In general, the district gives promise of a very large output when fully developed and doubtless will prove of great value as an addition to production from this area.

Successful development of the various fields lying along the route of the pipe line completed last year from Oficina to Puerto la Cruz followed exhaustive geological and geophysical studies carried on by Gulf Oil Exploration Company extending over the past twelve years. All drilling, production and pipeline operations of the Gulf's Venezuela interests are in charge of Chester M. Crebbs, president at the Caracas headquarters of the Mene Grande concern, with Hoyt Sherman as manager of Eastern Venezuela field operations.

Other companies that have holdings in the general area traversed by Mene Grande's pipe line are now actively engaged in developing these areas and have brought in several producing wells.

The full 90,000 bbl. daily capacity of the pipeline is not being used at present so the new discovery, even when more wells are drilled, will not necessitate additional overland transportation facilities in the near future, except for construction of a short connecting link and gathering lines. In addition to the lines from San Joaquin and Santa Ana previously referred to other feeder lines will be built as production develops.

The new producer at Santa Rosa was brought in at 6,530 ft. in 20 ft. of pay sand for 2,239 bbl. per day of 44.1 gravity API crude. The oil has a waxy base, which may make treatment desirable before introducing it to the pipeline for shipment. It has a 42 percent motor gasoline distillation yield, or 30 percent aviation gasoline. The high quality of the oil makes it exceptionally valuable bearing in mind the growing demand for aviation fuel, and that pipeline and road facilities are available; also that there are four modern refineries located within short sea hauls. Part of Mene Grande's crude is now being taken by Shell, which owns the huge refinery on the island of Curacao and a smaller one on Aruba. Gulf's refining facilities in Venezuela are limited to local requirements.

Oficina, at present the main eastern Venezuelan field, covers an area of about eight by

five miles and has 148 producing wells. The crude is of 30-36 gravity API. About 30 miles to the east the Leona-El Tigre area is under development. Three producing wells have been completed and the fourth is being drilled. A similar distance southwest and consequently nearer Oficina, is the Merey wildcat. Neither location has pipeline connection.

During recent months Socony-Vacuum has increased its drilling activities in Eastern Venezuela. In addition to three wells under way four are starting, or about to be spudded in. In the El Roble area, not far from Mene Grande's operations, Socony-Vacuum is down to over 7,000 ft. with Anaco No. 1, and it is expected that a producer will result. Sites for the four new wells were picked at Guario because the Company's Guario No. 1 and No. 2 already are producing 40-41 gravity crude, both over 1,000 bbl. per day. At San Joaquin, No. 1 and No. 2, also have been completed as producers and No. 3 and No. 4 are being drilled. About 30 miles southwest of Oficina, a Socony-Vacuum crew is drilling the wildcat Panchita No. 1 with a Diesel rig. In other operations steam rigs are being used.

Work is being carried out by the Sociedad Anonima Petrolera Los Mercedes, Caracas, owned jointly by the Tolima Land Company (Texas Petroleum Corp.) and the Caracas Petroleum Corporation of New York (Alfred Meyer). Geological and geophysical work is under the direction of J. A. Poulin, chief geologist. At Los Carito near Bocadeuracoa, a wildcat has been abandoned at 5,756 ft. One of the company's most interesting wildcats is Mercedes No. 1 located about 100 miles due south of Caracas, which hole was down to 4,908 ft. during the week ending Feb. 21 and at the time of writing had a showing of oil. A Diesel rig is being used.

Northwest of Oficina and below El Roble the company has been drilling Rincon No. 1 for a year past. Delay is due to a difficult fishing job at 9,605 ft.

Standard Oil of Venezuela is proceeding with what are described as routine operations in the development of its extensive holdings in eastern Venezuela. One of the most interesting wildcat operations that this company has under way is a well at Las Oilas west of Santa Ana, beyond El Chapparo, in the state of Anzaotegui, in an area not previously explored by the drill. The well is being put down in a section held jointly with Atlantic Refining Company.

In the El Roble field of the Pantepec Oil Company which is being developed by the Standard Oil Company of Venezuela under an operating contract, a third well has been brought in producing at the rate of over 2,000 bbl. daily from two separate zones. The lower sands extend from 9,620 ft. to 9,650 ft. and are deeper than those from which the first wells in this area are producing, indicating the existance of three or more separate zones. Oil is of 42 deg. A.P.I. gravity. A fourth well is drilling and two others have been located.

Government Contracts and Advertising Costs

ABSORPTION of plant facilities by defense contracts has raised a question of advertising policy in the case of many companies. Some have eliminated or greatly reduced their publicity activities but more adopt the attitude that it is important to maintain their position in their respective industries by continued advertising in view of the temporary nature of armament work. Among the latter there is some confusion as to the inclusion of advertising costs in overhead, particularly in the case of cost-plus contracts.

In order to clarify the position and to place the facts before readers, the executive editor of WORLD PETROLEUM recently took the question up with Washington, and urged upon the Secretary of the Navy the propriety of allowing manufacturers to include a reasonable amount of advertising expenses in overhead in cases where manufacturers and shipbuilders were partly or wholly engaged in naval work. He also interviewed John Sullivan, Assistant Secretary of the Treasury, and suggested that this procedure be adopted in the case of all government contracts, or else that companies be allowed to deduct a reasonable amount of advertising costs from the gross profits on government contracts, prior to computing the amount of income and excess profits taxes payable.

A letter since received from James Forrestal, Acting Secretary of the Navy, outlines the government's position, and is of considerable interest to companies who are in doubt as to Washington's policy. In this letter Mr. Forrestal makes it very clear that so far as general advertising is concerned, advertising costs cannot be included in manufacturers or shipbuilders overhead on government contracts, the reason being that advertising is not essential to the procurement of the contracts. However, the Acting Secretary adds the following pertinent information:

> "While the foregoing applies to general advertising, I am sure that you will be interested to learn that the Navy Department has accepted as allowable costs under a cost-plus contract a limited amount of expenses on account of advertising in technical and trade journals pertaining to the contractor's own industry. The reason for the acceptance of these limited expenses is that such advertising tends to promote and advance interest among technicians within a particular industry which, of itself, insures further development of the industry concerned. The advance and development of a particular industry, as a whole, is considered to be of value to the government, whereas general advertising, with a special sales appeal to the public should, in equity, be charged against the product advertised. In accordance with long established practice dating back as far as 1917-18, this latter class of expense has been consistently disallowed as a reimbursable item of expense to a contractor under a cost-plus contract."

A careful study of the foregoing makes it plain that companies engaged in manufacturing for the Navy Department on a cost-plus basis can charge to the government a reasonable amount of advertising costs in the trade press which they use in the course of their normal business.

But it is obvious that there is a very definite and clear limit to this action. To take an example, one large automobile manufacturer also constructs Diesel engines for submarines and naval surface craft. This concern obviously can advertise its Diesels in trade journals and include the cost in overhead on cost-plus contracts for the same; but this cannot be done with the advertising of its automobiles in national publications. The Navy Department ruling is clear in this particular.

However, there is an interesting ruling for manufacturers whose government contracts are on a competitive basis and not under the cost-plus arrangement, for Mr. Forrestal also states the following:

> "Your reference to the fact that the British Government allows any 'trader' e.g., manufacturer or shipbuilder, to deduct reasonable advertising expenses from profits on government contracts prior to computing taxable income and making payment of applicable taxes is, according to my understanding, precisely the procedure allowed by our government. It is my understanding that our manufacturers report all profits on government contracts as a part of their gross income and then proceed to make a deduction against the gross income for allowable business expenses, one of which is the cost of advertising. The allowance of this business expense as a credit against gross income prior to computing taxable income is under regulations promulgated by the Bureau of Internal Revenue, which are in no way applicable to the determination of allowable costs under a cost-plus contract."

The reference to the policy established by the British government since the outbreak of the present war is pertinent. Manufacturers in the United Kingdom found that government accountants disallowed all advertising charges to overhead where government contracts were concerned. The executive editor of WORLD PETROLEUM, in London at the time, realized the unfairness of the ruling and that it might have an adverse effect in the United States when Americans became more closely associated with the war. For two months he carried on negotiations with the Chancellor of the Exchequer, then Sir John Simon, also with the Board of Inland Revenue and with the President of the Board of Trade. Finally, on November 30, 1939, the British government made the ruling referred to in Mr. Forrestal's letter.

VOLUNTARY CURTAILMENT

Program of California Oil Producers

By A. H. BELL

Continental Oil Company
Los Angeles, California

Chairman, Conservation Committee of California Oil Producers

Presented at the Spring Meeting of the Pacific Coast District, A. P. I. Division of Production, Los Angeles, California, March 11, 1941, the Following Paper Constitutes a Reference Work on the History of Curtailment and the Formula now in Use in California.

THE migratory nature of underground petroleum reserves together with precedent established by the archaic "law of capture" rulings of the courts, has forced holders of competitive oil lands to develop those lands as fast as discovered. Discoveries of new oil fields have been grouped in waves following each step of advancement in geologic science. When most of the possibilities uncovered by any new method of exploration have been achieved there usually follows a period of waning discoveries during which the petroleum reserves accumulated during the previous period of intensive development are utilized. This condition has made the history of the petroleum industry replete with alternating periods of feast and famine in the matter of supply and demand.

In the early days of the industry with relatively small quantities involved, the surplus oil produced during periods of oversupply was stored in tank farms and held for periods of shortage the same as wheat is stored in elevators. However with the tremendous growth in the volume of oil consumed and the advance in technical knowledge regarding storage losses it has been found advisable in the interests of conservation to hold the surplus supplies in the ground for future use. Thus "proration" or "curtailment" has become standard practice in the industry.

Many states have laws requiring curtailment of crude oil production in the interests of conservation and prevention of waste during periods of oversupply. Two such laws have been passed by the California Legislature but in each case have been defeated by referendum vote of the people.

HISTORY OF CURTAILMENT

As far back as 1922 overproduction in California forced temporary curtailment at Santa Fe Springs and other flush fields in Los Angeles Basin and the heavy oilfields of San Joaquin Valley. In the spring of 1929 K. R. Kingsbury headed a committee of important producers who on April 22 appointed F. C. Van Deinse as Umpire. He had an advisory committee of engineers headed by T. E. Swigart and the proration orders called for voluntary straight percentage cuts on all wells in an attempt to hold production to the 1928 levels. After a short period Mr. Van Deinse resigned and the program was abandoned, largely because of lack of appreciation on the part of smaller producers as to the necessity for the program.

Mounting production and falling demand in the fall of 1929 caused the operators at Santa Fe Springs to set up a proration program with H. P. Grimm employed as Umpire on November 1, 1929. At the same time the operators at Long Beach set up a similar system under Neal H. Anderson. In December of that year the Santa Fe Springs plan was expanded to include Elwood and Ventura Avenue Fields. Other fields such as Seal Beach and Murphy Coyote where only two or three operators were involved, were curtailed as early as September 1929 without formal programs.

By February of 1930 the necessity of a statewide program became apparent and the "General Committee for California Oil Curtailment" was formed with Paul N. Boggs as chairman. The committee was composed of eight independent company representatives and seven major company representatives.

The committee started functioning by accepting and tabulating the voluntary offers of cuts in production by the various operators in the flush fields with no requests for curtailment by small or settled fields. After establishment of field totals by the voluntary nomination method the allotments of company totals were based on straight percentages applied to potentials. The only exceptions were for wells making large quantities of water.

The inequities of applying percentage cuts to large and small wells alike and the difficulties of correlating two more or less competitive umpire organizations caused a certain amount of dissatisfaction among the operators. On July 28, 1931 the two organizations were merged with Neal Anderson becoming State Oil Umpire, and R. E. Allen assistant umpire.

When the method of applying percentage cuts to the potential of wells was first used the operator's actual prior production was sufficient evidence of potential. After the plan had been in effect for a period of time difficulties arose in establishing the true conditions. The General Committee appointed a Fact Finding Committee with W. E. (Steve) Dunlap as chairman to carry on the engineering work necessary to guide the committee.

As a result of criticism of established potentials, open flow tests were held at Santa Fe Springs, Long Beach, Ventura and Elwood, and during these tests the state's production rose to 806,000 bbl. per day and the state potential was set at 1,095,000 bbl. In March 1930 the state allowable was set at 609,000 bbl. per day.

A. T. Jergins as chairman of the Long Beach Oil Operators Association and Herbert Macmillan as president of the California Oil and Gas Association were both active leaders in the General Committee with Mr. Boggs becoming less active following the electioneering that started over the referendum on the Sharkey oil control bill.

When the Sharkey bill was defeated the General Committee resigned on May 7, 1932 but Mr. Anderson remained in office as interim umpire. On May 19, of the same year a new committee called the "Oil Producers Central Proration Committee" was formed with H. P. Grimm as chairman. This committee designated three delegates to represent them on the Committee headed by Wm. Keck, Sr. and known as the "Executive Committee for Equitable Curtailment". The Executive Committee undertook to establish a new deal in proration policies and among other things appointed J. R. Pemberton as umpire on July 13, 1932 following the resignation of Neal Anderson. The following April the "executive committee" was dissolved and the dormant "central committee" again took over.

The state oilfields were then divided into eighteen districts and an election was held in June 1933 with the chairman of each district becoming a member of the reorganized "Central Proration Committee". Ralph B. Lloyd, who had been appointed a member at large, was elected chairman.

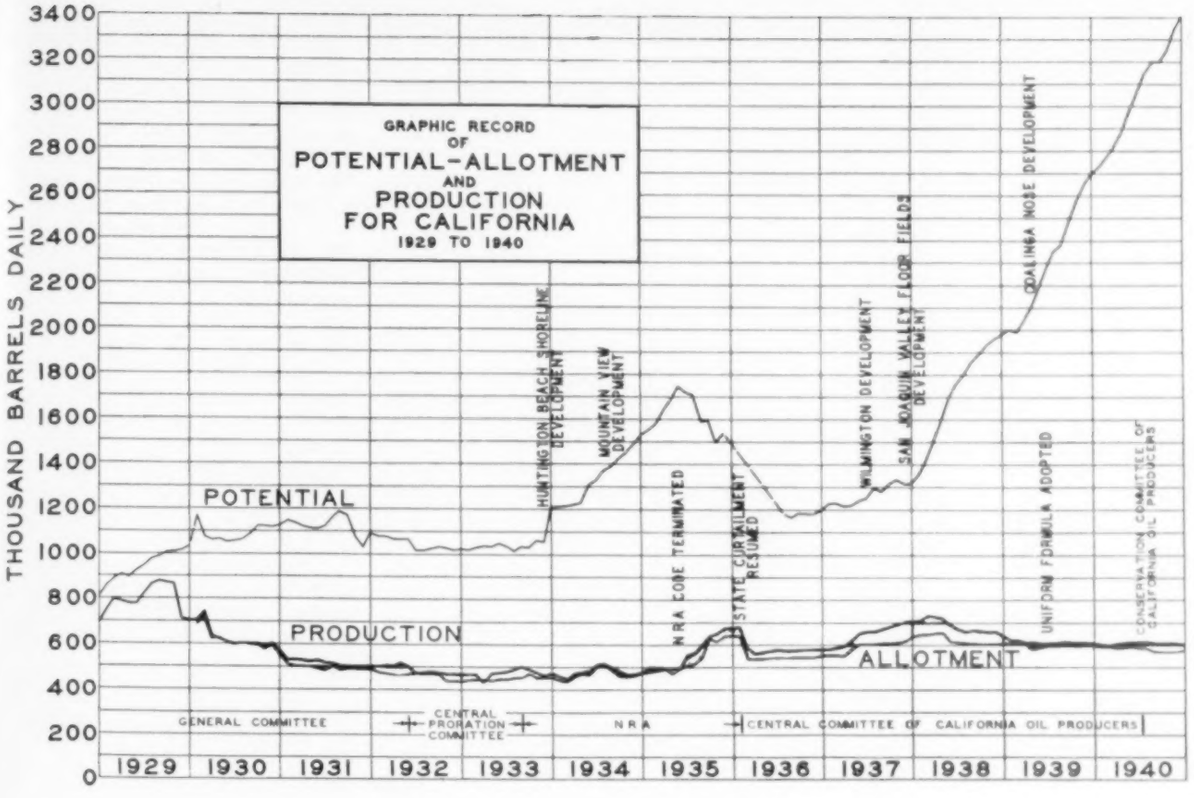


PLATE 1

FIGURE 1

Following the adoption of the Code of Fair Competition for the Petroleum Industry under the N. I. R. A. on August 19, 1933, Secretary of the Interior, Harold L. Ickes as National Petroleum Administrator, on September 2, 1933, designated the Central Committee as the agency for allocation of crude oil production quotas within the state. The name of the committee was changed on September 22, 1933 to the "Central Committee of California Oil Producers". Mr. Lloyd continued as chairman with Mr. Pemberton as umpire and Mr. Allen as assistant. Howard Marshall was designated as representative of the National Administrator to advise with the Committee. On October 20, 1933 the Central Committee added eight members to its roster and under the operator's support of the Code great advancement in the formulation of a more uniform method of allocation was made. In attempting to apply a uniform formula throughout the state the committee found the supply of heavy oil as compared to light oil would be seriously upset. They proceeded with the approval of the federal representative, to apply a market demand factor to the formula to reduce the allotment under the uniform formula in certain districts. The committee also formulated plans for orderly or deferred development of new fields. Because of the fact that the committee was acting under law their actions were rapidly becoming more cumbersome with an influx of lawyers into the picture. The formula applied to Kettleman Hills was contested and appealed to the board in Washington, which gave a decision involving a formula modified by bottom hole pressures which caused considerable confusion in its application.

Shortly after this, in May 1935, the N. I. R. A. was declared unconstitutional and the enforcement of curtailment through the crude purchasing companies ceased. The Central Committee then reverted to its pre-code status with an increase in membership from eighteen to twenty-two district chairmen, plus three members at large, representing the Valley, Coast and Los Angeles Basin.

Production control became demoralized after the failure of the N. I. R. A. despite attempts of a "Committee of Seven" appointed at a mass meeting on June 17, 1935, to obtain signatures to an "agreement between producers of Crude Petroleum in the State of California."

In July Mr. Lloyd resigned as chairman of the committee and Lawrence Vander Leck was elected chairman on July 16, 1935. The committee ceased to function after August 29, 1935.

Although some of the operators continued following interim allocation schedules and despite the efforts of the "Emergency Curtailment Committee of Independent Producers" headed by Mr. Vander Leck, production rose to 673,000 bbl. per day in January 1936. Mr. Vander Leck then called the old Central Committee together January 14, 1936 and the December 1935 actual production of the various fields was used as a base from which straight percentage cuts were taken even though some of the fields were partly curtailed. Except for the reallocation of decline in old fields to fields having new wells on a power factor formula the method of fixed allotment to pools remained in effect until 1939 when the uniform formula for all wells was adopted. In many of the fields however the allocation between wells was based on the uniform method.

Mr. Allen resigned as assistant umpire in May 1936 and W. R. Wardner was appointed in his place May 1937 with Mr. Pemberton remaining as Umpire except for a three months leave in 1938 during which time Mr. Vander Leck took on a full time assignment with salary which continued thereafter jointly with Mr. Pemberton.

Gradual increase of dissatisfaction with the pegged pool method led to the appointment in December 1938 of a "Fact Finding Committee" headed by W. S. Rosecrans and an "Emergency Executive Committee" headed by E. E. Pyles who made statewide investigations into methods and results and recommended that a uniform formula be adopted.

Accordingly the Central Committee through its allocation committee headed by L. L. Aubert, as of June 1, 1939, evolved a uniform formula for every well in the state based upon:

(1) A minimum allotment for every well which increased with depth.

(2) A proportion of the potential remaining after deducting the minimum allotment, which was based on a graduated

power factor curve giving smaller percentages to the larger wells.

(3) An arbitrary top allotment for any well regardless of allotment calculated under 1 and 2.

In May 1940 the Committee was enlarged to one representative from each of twenty-nine districts plus five members at large and Mr. Vander Leck was elected to fill the position of both umpire and chairman. On June 20, 1940 Mr. Vander Leck resigned effective July 16, 1940 and subcommittees were appointed who recommended reorganization of the Committee.

Figure I shows graphically the state potential, allotment and actual production from 1929 to date and shows clearly how the mounting potential of recent years has been successfully controlled under the voluntary system.

PRESENT ORGANIZATION

The Committee changed its name to the "Conservation Committee of California Oil Producers" and elected A. H. Bell as chairman. L. P. St. Clair was chosen to take the position of Administrator with W. R. Wardner as Assistant Administrator. Mr. St. Clair agreed to serve only on the basis of no salary.

L. L. Aubert was retained as chairman of the allocation committee and Paul Huggins was chosen to head the administrative committee. All of the above officers are serving at the present time.

Throughout the period since 1929 constant progress has been made in organization procedure, administrative procedure and scientific construction of formulas and determination of potentials. There has been gradual establishment of precedent and public opinion to insure cooperation on the part of the 1,125 operators in the state who today are curtailing a potential production of 3,449,000 bbl.per day down to 601,745 bbl. per day. This is without benefit of enforcement laws but based on rules established in a truly democratic and formally legislative manner by duly elected representatives who are bound by majority decisions. It is only while the average producer has confidence in the equity of allotments recommended by the committee that such voluntary cooperative spirit as has been shown is possible.

At the present time the committee consists of 29 members who are nominated and elected with alternates from producing districts and five members at large elected by the committee. There are a chairman, two vice chairmen, secretary and administrator who have the privileges of the floor. Each alternate has the privilege of the floor and service on committees but votes only during absence of his principal.

The Administrative Committee determines assessments per barrel of oil necessary to support the organization and determines fiscal policies of the office.

The Allocation Committee determines method and amount of allocation each month and methods of determining potentials.

A third committee functions at intervals to work on drilling forecasts and rate of development problems.

All committee decisions are subject to review by the main Conservation Committee before becoming final. Rules provide for rotation on committees so that all classes of operators are assured of representation while all terms of office automatically expire each spring with the annual elections of district chairman to constitute the new committee.

UNIFORM FORMULA

Marginal properties and marginal wells are those whose normal production without restriction is necessary to insure their continued operation. In most cases this is the old economic problem of producing sufficient income to offset operating expense with a very small margin of profit remaining as a return on the original capital investment. As this type of production is generally from a large number of old wells of a very settled nature, it represents a backlog of our reserve. The characteristic decline of this type of property is very slow and the preservation of the wells of vital economic importance to provide a future supply.

As designated by the Conservation Committee a marginal property or well is one whose potential is less than the total exemption provided under the minimum formula for that particular depth. Several factors have been taken into consideration in developing the exemption of marginal properties, the most important being the average lifting cost. As these wells are nearly all pumping, the lifting cost is relatively high on a per barrel basis. This may be called a living wage provision and is a fundamental in production allocation to promote conservation by allowing the wells to be produced down to the economic limit. Curtailment in many cases would result in loss from edgewater encroachment or water flooding and a premature abandonment of the well which would result in loss of an irreplaceable commodity to the industry and the public. The employment given to labor to keep these marginal properties on production is another important reason for the liberal treatment given. Labor is the greatest item of cost on this type of property, because of the amount of equipment used per barrel of production and the

CONSERVATION COMMITTEE OF CALIFORNIA OIL PRODUCERS

1940 - 1941

Chairman
A. H. Bell

1st Vice-Chairman	2nd Vice-Chairman
M. A. Machris	Lloyd Williamson
Secretary	**Asst. Secretary**
F. M. Ziegler	Bettye Bohanon

Dist. No.	Member	Alternate	Fields Represented
1	Max S. App	J. B. Wharton	Belridge North, Belridge South—Lost Hills
2	H. S. Stark	R. L. Keyes	Buena Vista—Elk Hills
3	R. D. Montgomery	Fred E. Smith	Coles Levee, Paloma, Strand, Ten Section
4	W. S. Fisher	Frank Wells	Coalinga East & West
5	R. S. Lytle	E. H. McCullough	Coalinga Nose and Coalinga Northeast
6	J. H. Sargent	R. I. Brown	Kettleman Hills
7	R. N. McMaster	D. L. Caldwell	Mt. Poso—Round Mt.—Coffee Canyon
8	Lloyd Williamson	J. L. Bowen	Poso Creek—Fruitvale—Kern Front—Kern River
9	Ross McCollum	Harry Campbell	Mountain View—Edison
10	H. F. Owen	A. J. Crites	Midway—Maricopa—McKittrick—Lake View
11	Wm. H. Morgan	Warren Smith	Santa Maria Valley
12	W. H. Geis	O. C. Field	Gato Ridge, Lompoc, Cat Canyon, Casmalia, Orcutt
13	L. L. Aubert	R. R. Boyd	Capitan, Rincon, Newhall, San Miguelito, Elwood
14	Joseph Jensen	Wm. L. Hobro	Ventura Avenue
15	S. P. Mullen	A. A. Anderson	Santa Barbara, Summerland Sargent, Santa Paula
16	A. H. Bell	Warren Craddock	Alamitos Heights, Seal Beach
17	Lawrence V. Leck	Donald Riley	Brea-Olinda, Richfield, Coyote East and West, Yorba Linda
18	Harold Wyatt	E. D. Hardison	Dominguez
19	Laurence C. Kelly	C. C. Spicer	Playa del Rey, Potrero, El Segundo, Lawndale
20	M. A. Machris	A. M. Anderson	Huntington Beach
21	Warner Clark	Quay S. Diven	Inglewood
22	Wilbur Harrison	Neal Elder	Long Beach
23	F. M. Ziegler	R. H. Garrison	Montebello, Whittier
24	W. C. Whaley	L. R. Rogers	Rosecrans-Athens
25	V. H. Wilhelm	Henry Power	Santa Fe Springs
26	E. Robert Burns	Neal H. Anderson	Torrance-Hermosa
27	C. G. Williams	Allan A. Jergins	Wilmington-Long Beach Area
28	George Ring	W. H. Eastham	Wilmington Town Lot Area
29	Wm. Keck, Jr.	R. W. French	Greeley, Rio Bravo, Wasco

MEMBERS-AT-LARGE

San Joaquin Valley	Emil Kluth
Los Angeles Basin	E. E. Pyles
Coastal District	John Sutherland
State-as-a-Whole	R. P. Huggins
Calif. Stripper Well Assoc.	Richard Fenton

ADMINISTRATIVE COMMITTEE	ALLOCATION COMMITTEE	NEW WELL COMMITTEE
R. P. Huggins, Chairman	L. L. Aubert, Chairman	C. G. Williams, Chairman
R. D. Montgomery	R. I. Brown	R. R. Boyd
E. E. Pyles	Wm. L. Hobro	W. C. Whaley
H. S. Stark	V. H. Wilhelm	R. L. Keyes
Laurence C. Kelly	Richard Fenton	L. R. Rogers
	Wm. Keck, Jr.	
	Lloyd Williamson	

ADMINISTRATOR: L. P. St. Clair **ASSISTANT ADMINISTRATOR: Wm. R. Wardner, Jr.**

COMPTROLLER: Joseph Kearns

fact that the equipment is generally old and continually in need of repair.

Figure II shows graphically the grouping of wells of various potentials. It shows clearly that the large majority of the wells in the state are in the stripper class and as such are not asked to participate in curtailment.

In applying the minimum allotment formula the rule provides that no well shall be allotted less than ten barrels per day, if capable of that production. This is called the irreducible minimum. The application of the depth minimum formula is therefore limited to wells deeper than 1,850 feet. At this depth a well earns the ten barrel minimum allotment under the formula.

The first step in the formula is that all wells regardless of their potentials receive depth minimum allotments. Any well whose potential is less than the depth minimum under the minimum formula for that particular depth is classified as a marginal well. In all cases the minimum allotment is given first before any further consideration is given to potential. The minimum formula originally provided five barrels per day for each 1,000 feet of depth. This depth minimum was set up to compensate for greater lifting costs and investment for the deeper wells in direct proportion to depth. The accelerated minimum which is now in effect takes into consideration the fact that drilling costs increase at a rate greater than direct proportion with depth. At present the well receives five barrels for the first 1,000 feet, five barrels plus .75 barrel for the second thousand feet, 5.75 barrels plus .75 barrel or 6.50 barrels for the third thousand feet and so on. Algebraically this may be expressed as an arithmetic progression. The general equation being:

$$S = \frac{n}{2}\left[2a + (n-1)\,d\right]$$

When S = summation of terms
a = first term
d = common difference
n = number of terms

The problem has given **a** the minimum allotment for the first 1000 feet, **d** the progressive increase factor and **n** the depth of the well expressed in 1000's, and to solve for **S**, the depth minimum allotment. Changing symbols and substituting known values the equation is written as follows:

Let M.A. = Minimum allotment at a given depth (summation of terms)
D = Well depth in feet.

$$n = \frac{D}{1000}\text{ (where n is number of terms)}$$

substituting in the above equation,

$$MA = \frac{D}{2000}\left[2a + \left(\frac{D}{1000} - 1\right)d\right]$$

when D equals .75 and A equals 5

$$MA = \frac{D}{2000}\left[10 + \left(\frac{D}{1000} - 1\right).75\right]$$

$$= \frac{D}{2000}\left(9.25 + \frac{.75D}{1000}\right)$$

Example; when depth D = 5600'

$$\text{then } MA = \frac{5600}{2000}\left(9.25 + \frac{.75 \times 5600}{1000}\right)$$

$$= 2.8\,(9.25 + 4.2)$$

$$= 37.66$$

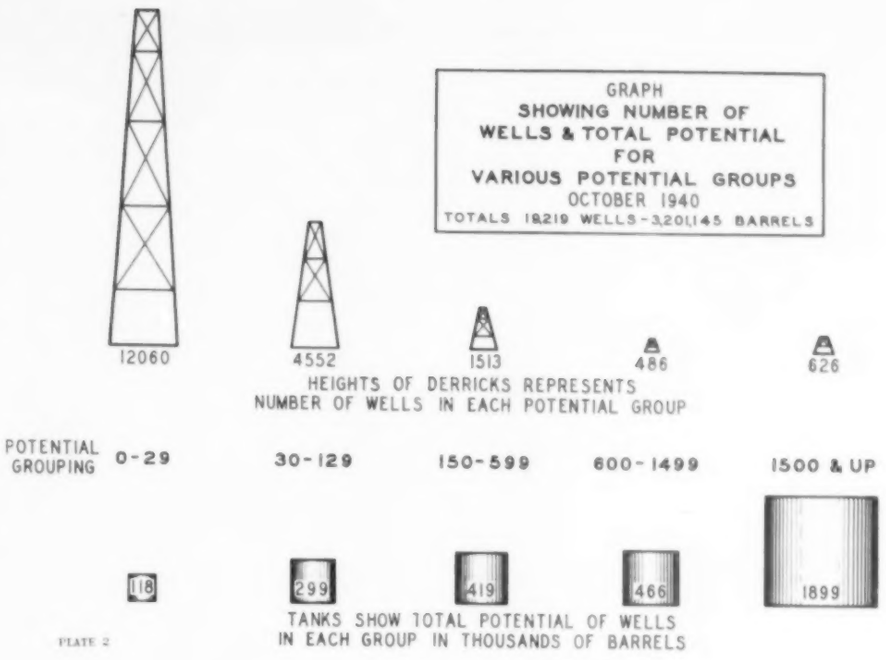


FIGURE II

Changes in Depth Minimum During 1940

Progressive Increase Factor	June 1, 1939 Depth Minimum	July 1, 1940 Depth Minimum	Sept. 1, 1940 Depth Minimum	Feb. 1, 1941 Depth Minimum
	1.0	.9167	.8334	.75
a— 1950	10.0	10.0	10.0	10.0
2000	11.0	10.9	10.8	10.8
3000	18.0	17.8	17.5	17.3
4000	26.0	25.5	25.0	24.5
5000	35.0	34.2	33.3	32.5
6000	45.0	43.8	42.5	41.3
7000	56.0	54.3	52.5	50.8
8000	68.0	65.7	63.3	61.0
9000	81.0	78.0	75.0	72.0
10000	95.0	91.3	87.5	83.8
11000	110.0	105.4	100.8	96.3
12000	126.0	120.5	115.0	109.5

In the actual application of the depth minimum formula for practical consideration minimums are given to each well to the nearest whole number and fractions are not used. A table is constructed so that the wells within a given depth range receive the same minimum. To illustrate: a well at 5583 feet by the formula would receive 37.5 bbl/d, while at 5695 feet it would receive 38.5. Therefore any well between these two depths is given 38 bbl/d depth minimum allotment.

When the accelerated minimum was first adopted the result was to increase the allocation of light oil in the state and decrease that of heavy oil. This was justified because there had been an increase in heavy oil storage during the preceding three years, 1936, 1937, and 1938, amounting to approximately 26,000,000 bbl. In the following two years, 1939 and 1940, however, approximately 17,000,000 bbl. have been withdrawn from heavy oil storage due to a greater demand for fuel oil and a wider utility for heavy crude in cracking. Also as a result of curtailment and natural decline the supply has been diminished by approximately 12 percent. As the deep wells are generally light gravity a reduction in deep well minimum by cutting the progressive increase factor would tend to decrease the allocation to light oil wells. Recent cutting of the minimum has thus transferred more of the burden of providing for new wells on to the deeper light oilfields. Some further consideration to heavy oil allocation and transfers of heavy oil allowables to light oilfields will be necessary if the proportion of heavy oil production in the state is to be increased in sufficient quantities to balance the present supply with demand.

The second step in the formula is commonly known as the sliding scale percentage curtailment, namely that percentage of curtailment applied to the potential remaining after deducting the minimum allotment. This graduated percentage of remaining potential to determine the remaining allotment is applied to all intermediate wells, which may be classified as wells which are neither marginal nor top. The principle which is applied in allocating production to oil wells on this basis is similar to the income tax method wherein those with the largest incomes are best able to bear the burden. Similarly, those wells with the largest potentials are able to take the greatest percentage of curtailment. This is entirely an economic consideration to which have been applied engineering and mathematical principles. It has been a means of obtaining the greatest amount of curtailment with the least burden to the small well. The first application of a sliding scale curtailment in California was made in 1931 in the Midway field where the field was divided into groups based upon the potential of each operator, and a different percentage of curtailment was used for each class. A refinement of the system was put into effect in 1933 during the N. R. A. time when the power factor method was adopted.

Under the original method of straight percentage of remaining potential the larger

wells consumed a disproportionate share of the state allotment. Tremendous flush potentials of new fields under the straight percentage method resulted in bringing the allotment down to such a small fraction of potential that when it was applied to relatively small wells, say 50 bbl., it would result in an allotment which could not be adhered to. Thus, the tendency to concentrate large quantities of the state allotment in the flush fields at the expense of the small settled production resulted in the adoption of the sliding scale percentage curtailment.

In order to simplify the procedure and furnish a tool which could be applied readily the power function curve was adopted. The simple power function curve is a straight line when plotted on logarithmic paper, with the line passing through the unity point of both axes. As an illustration a simple application of the power factor would be the square root of a number. This may otherwise be expressed as the one-half or .5 power of a number. The application of the .5 power would however have been too drastic a cut and the first power factor used under the uniform allocation formula in June 1939 was the .76 power. Under this method the minimum allotment is deducted from the potential of each well and the remaining potential is then modified by the power factor to obtain the remaining allotment. The following illustrates the use of the simple power function formula:

P − MA = R.P. P = Potential
MA = Minimum allotment
RP = Remaining potential

RP raised to the n power factor is written $RP^{/n}$
When n = .76 = power
$RP.^{76} = RA$ (Remaining allotment)
To solve for RA when RP = 500
$RA = 500.^{76}$

log RA = .76 log 500
= .76 x 2.698970
= 2.0512
antilog = 112.517

During the first twelve months' operation of the uniform allocation formula the power factor was reduced at various times from .76 to .728. The effect of this reduction to all intermediate wells in the state was to cut the remaining allotment to these wells approximately 850 bbl. for each .001 cut in the power factor. Because these cuts were seriously impairing the allotments to small wells and the increasing burden felt by this class was hazarding their continued operation under voluntary curtailment, a change in the power factor curve was adopted. A further effect of the continued use of the simple power factor was that, with gradual reduction of the top allotment, successively smaller amounts of potential were being required to earn the top allotment.

The new type of power function curve which does not change materially from the straight power curve at the lower limits, also plots a straight line on logarithmic paper but does not pass through the unity point of both axes. The curve is selected by a trial and error method. The point above which the change is to be made is selected by the committee and the amount of remaining allotment to be cut off by the formula is determined from the known requirements for new wells. Thus,

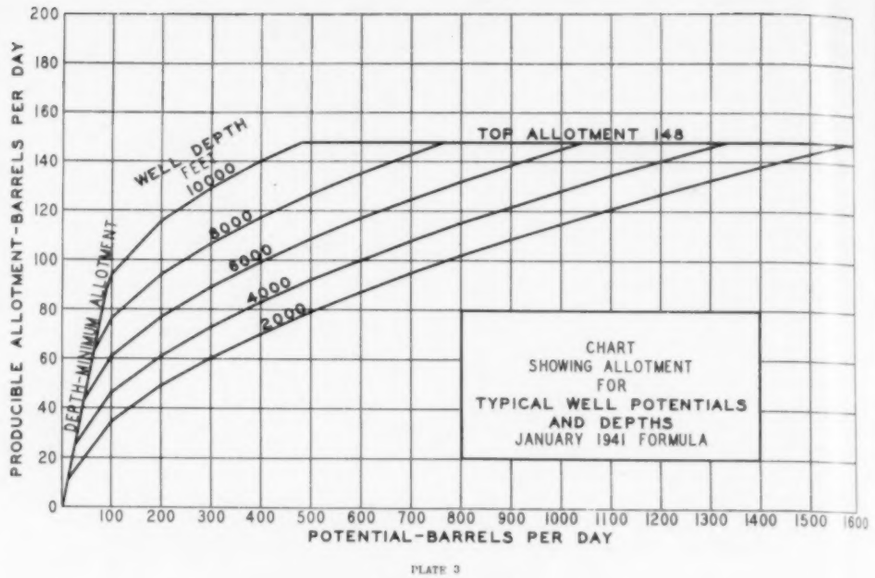


PLATE 3

FIGURE III

having established a point below which no change is made, and knowing the volume of oil to be taken by the formula, it is a matter of the number of wells in each particular potential group which will determine the shape of the curve. Its exact position, however, must be selected by a process of trial and error. The mathematical type of equation now used is as follows:

$y_1 = b\,x^n$ where y = remaining allotment
let $y_1 = y + a$ a = a constant
then $y = bx^n - a$ b = a constant
x = remaining potential
n = power factor

The formula in use for February 1941 is:

$RA = 1.962\ (R.P.)^{.5794} - 2.49$

The following table illustrates:

R. P. (x axis)	R. A. (y axis)	Rate of change of R. A. with respect to R. P.
B/D	B/D	B/D
10	5.0	.43
25	10.2	.30
50	16.4	.22
100	25.8	.16
200	39.8	.12
400	60.7	.09
600	77.4	.08
800	91.9	.07
1000	104.9	.06

By differentiating y with respect to x the rate of change in remaining allotment per barrel of remaining potential for different points on the curve is shown in the right hand column.

The top or maximum allotment is the third feature in the uniform allocation formula. This is a flat top without regard to the well depth and is uniform for all wells capable of earning the top under the formula. Under the present heavy curtailment, a relatively small amount of potential is required to receive top allotment. Considering the large potentials of some wells, this will vary from 400 bbl. at great depths (11,000 feet) to 1,500 bbl. at shallower depths (2,000 feet). The effect of this feature has been to discourage potential tests at extremely high rates.

The top allotment for February 1941 was placed at 147 bbl/d. This has been reduced 103 bbl/d from the original figure of 250 bbl/d in June 1939, so that over the 21 months' period the top has been cut on the average of five barrels per month. Recently, however, the reduction has been in the neighborhood of one or two barrels per month. Curtailment on top wells is closely adhered to and voluntary compliance with these cuts has thus substantially reduced production.

The effect of cutting the top allotment is that it takes less potential to earn the top because the spread between the minimum allotment and the top allotment becomes progressively less. Offsetting this effect, the reductions which have been made in the power function curve tend to require a greater amount of potential to earn the top. As the power function curve is brought down it becomes flatter at the higher extremity and the greatest cuts have thus been taken on the upper potential group. To illustrate—during the first seven months use of the compound power factor curve, the remaining allotment given a remaining potential of 500 bbl/d has been cut 17.3 bbl/d while for a remaining potential of 100 bbl/d it has been cut 2.2 bbl/d. Putting it another way it now takes 725 bbl/d remaining potential to receive the same remaining allotment given to 500 bbl/d remaining potential in July 1940.

Figure III shows graphically the allotment given to wells of various depths and potentials under the January 1941 formula.

The amount of variable depth minimum allotment has a considerable effect on the potential required to obtain top allotment. As the top is a flat figure and the depth minimum accelerates with depth the spread between the top and the depth minimum allotment decreases as the depth increases. Thus at 4,000 feet when the top is 147, minimum allotment is 24½, and the remaining allotment 122½. This remaining allotment accrues to a remaining potential of 1290. When we consider a well 8000 feet deep, the minimum allotment is 61 and the remaining

allotment 86 which only requires 716 barrels per day remaining potential. This limiting feature in the potential as has been previously stated eliminates the necessity of demonstrating high potentials; for example, at 8000 feet there is no difference in allotment between a well with a potential of 777 barrels and a well with a potential of 7000 barrels. A well with a higher potential will however, remain a top well for a greater length of time because it will take longer to reduce the potential through natural decline to the point where it goes out of the top class into the intermediate class.

CONCLUSIONS

The scarcity of new field discoveries in the last two years indicates that the future outlook for California producers is more favorable than it has been for some time. During the past year the state produced 223,881,712 bbl., but in spite of new drilling the net reserves of the state were approximately 15 to 20 million barrels less at the end of the year. However an examination of storage figures indicate that we still have to "pay the piper" for our excesses of the past before we can look for increased allowables.

When one considers the pressure that is being brought for some sort of statutory control, either federal or state, it is evident that voluntary curtailment is on trial and must make good through full compliance or revert to danger of "dictatorship" through law or "survival of the fittest" through abandonment of any control.

Some few operators who may pride themselves on being "rugged individualists" or being clever in failing to follow the voluntary curtailment plan would feel less proud if they could see themselves in the mirror as a small group who are currently depriving each of the small operators of the state of a barrel or two more per day that would otherwise be allotted if adherence to the recommended schedules were complete.

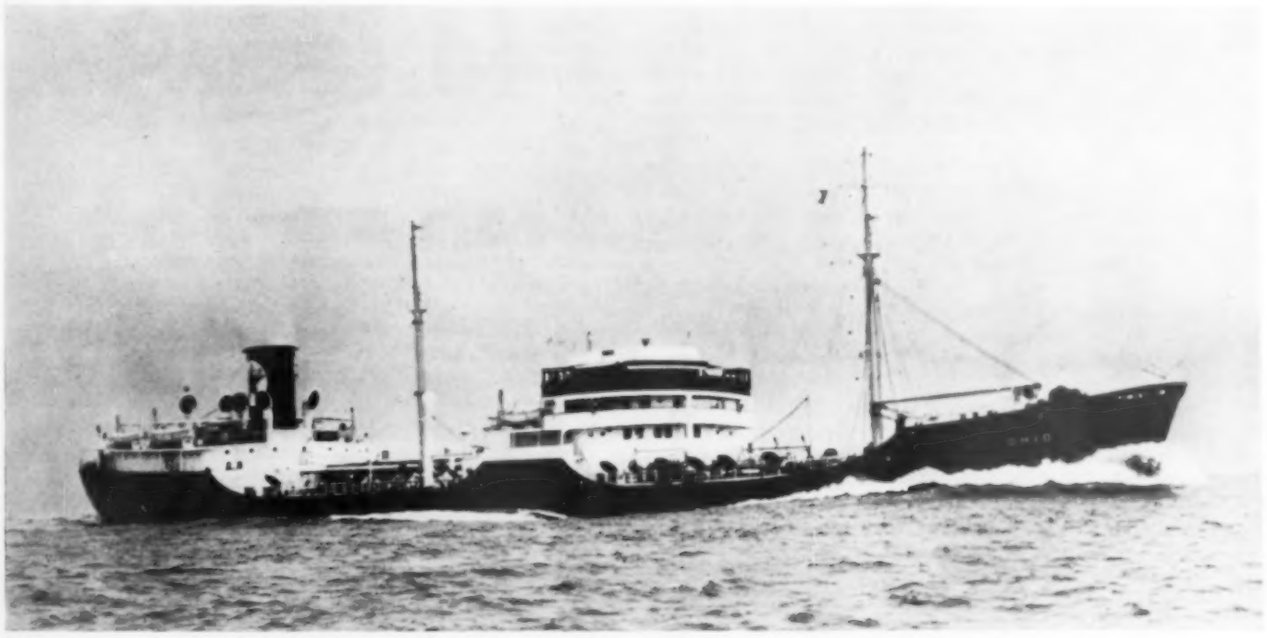
ACKNOWLEDGMENTS

The author wishes to acknowledge the assistance of W. R. Wardner, Jr., who prepared the material for the section describing the formula now in use. Acknowledgment is also made to Joseph Jensen, R. I. Brown, and Wendell Thayer for assistance in providing historical and statistical data.

Shell builds a gasoline pipeline through the frozen ground of New England to Boston.

German Imports via Russia

Constantin Oumansky, Soviet Ambassador at Washington, has given official assurances to the State Department of the United States that imports of American goods into the Soviet Union are for the sole use of the government and industry of his country and do not directly or indirectly serve to supply Germany.



Steam driven tanker Ohio, built for the Texas Company by Sun Shipbuilding. Typical of the current trend in high speed bulk oil carriers, she developed trial speed of 17.21 knots, deadweight 14,150 tons.

Geology and Economic Significance of the Northern GREAT PLAINS BASIN

By Joseph A. Kornfeld

Consulting Geologist, Wichita, Kansas

The Very Active Leasing Campaign in North and South Dakota During 1940 Which Attracted Widespread Attention Suggests a Comprehensive Study of the Northern Great Plains Area With Special Reference to the Dakotas.

ONE of the undeveloped reserves of petroleum on the North American continent lies in the Northern Great Plains Basis stretching throughout eastern Alberta, Saskatchewan and Manitoba and extending southward into the Willison basin of North Dakota and Montana.

Recent deep drilling has indicated promising discoveries and new objectives in a sedimentary section which extends approximately 15,000 ft. in thickness.

Currently, the search for new reserves is accelerated on both sides of the International Boundary.

On the Canadian side, the European War has precipitated a drive for self-sufficiency of oil reserves in Canada. An added factor has been the rigid controls on the use of dollars for purchase of imports. In this connection, George R. Cottrelle, Dominion oil controller, recently said that "Not one dollar of our vital and limited supplies of foreign exchange is to be spent on foreign oil that can be saved."

As a war measure, effective January 18, Cottrelle increased crude oil quotas from Turner Valley from 22,000 to 25,000 bbl. daily. At that, this represents only two-thirds of the total capacities of the interior group of Canadian refineries rated at 40,550 bbl. daily as of November 1, 1940. Any new oil discoveries in North Dakota and Montana will affect the flow of crude into Canada, now that the Illinois flush output is less than two-thirds of its June, 1940 peak figure.

Reflecting the opinion of the larger exploration groups in Canada, G. Harrison Smith, Toronto, president of the Imperial Oil Company, Ltd., in a recent statement, said that "exploration for domestic (Canadian) sources of crude oil is being carried on, on an enlarged scale, for the industry is fully aware how great a contribution might be made to the war effort through discovery of new fields to supplement the production from Turner Valley, which is currently the only important producing field in Canada."

Recent discovery late in December of flowing oil production from the Paleozoics, east of the foothills in Alberta marks one of the greatest incentives to exploration this vast geosyncline has ever received. The discovery well of the new Princess field at Steveville brought in by the Standard Oil Company of British Columbia, marks the largest oil well ever completed in Canada outside of the vast Turner Valley field. It is advantageously located from marketing standpoint being 150 miles closer to the Manitoba and Saskatchewan refineries than is Turner Valley. A deepening program in addition to new adjacent development is underway.

An encouraging factor in the search for deeper limestone production in this basin is the successful use of acid treatment in increasing the output of the Madison (Rundle) limestone at both Turner Valley and Princess. In addition, the technical success of the reflection seismograph in outlining the truncated Paleozoic structures of limestone that lie unconformably beneath the vast mantle of Mesozoic sandstones and shales, will encourage widespread exploration and leasing in this geosyncline.

In this vast trough, important oil reserves lie at considerable depths in the Jurassic, Mississippian and Devonian beds. Most of the Paleozoic rocks are saturated with oil at their outcrops on the north and east flanks of the synclinorium. This fact, together with the existence of numerous stratigraphic conditions throughout both the lower Mesozoic and Upper Paleozoic systems, warrant the search for new reserves.

The largest single known oil reserve in the world lies in northeastern Alberta near the northern end of the Moose Jaw synclinorium near McMurray 250 miles northeast of Edmonton. Exposed along Athabaska river and its tributaries near McMurray lies the famous Athabaska-McMurray sands of lower Cretaceous age. Although Max W. Ball, prominent Denver geologist, places the oil content of this reserve at from 100,000,000 to 500,000,000 bbl., he states that "in all probability only 1,000,000 bbl. are accessible to development at present day prices. These extend 76 miles north and 42 miles southwest of McMurray. Whether or not the oil was derived from the underlying Devonian limestone has been the subject of long argument by geological authorities but its occurrence in this part of the regional trough is a positive factor as to the petroliferous character of the region.

On the American side of the boundary, the search for new reserves has been accelerated since the flush Illinois fields passed their peak of 500,000 bbl. daily in June, 1940. Since that time, more than 8,000,000 acres have been leased for oil and gas rights in the Williston basin extending throughout central North Dakota and South Dakota.

The author, Joseph A. Kornfeld

Princess Field. One of the most important oil discoveries ever recorded in the Southern Plains of Alberta was completed on December 31, 1940, in the Steveville field at Princess Siding by the Standard Oil Company of British Columbia. This area is situated 110 miles east of Calgary and six miles east of the town of Patricia.

Significance of the discovery is the finding of commercial oil from the truncated, bevelled Paleozoic limestones on the Sweetgrass arch extending along a trend from the Vermilion field in Alberta southward to the Kevin-Sunburst field in Montana.

One of the oldest known surface structures in the southern plains area, the Steveville structural feature, was mapped as far back as 1885 when it was worked by Dr. G. M. Dawson. However, the first important geological investigation was made by Joseph S. Irvin, Calgary consulting geologist, a few years ago for the Dawson-Steveville syndicate and the Altoba Agencies. These firms were successful in interesting both the Standard of British Columbia and the Anglo-Canadian Oil company, each of which drilled three wells on the structure. John Galloway, geologist with the Standard, mapped the area prior to the new oil development.

Small oil showings were logged in the deep Paleozoic formations in the first tests which

had found large gas flows in the Rundle (Madison formation of Mississippian age).

The discovery oil well is Standard of British Columbia No. 2 Princess, L S D 3, 13-20-12w4, which was originally drilled to a total depth of 4,250 ft. in the Devonian line. It was plugged back to 3,920 ft. to test the Madison and the seven inch oil string was cemented at 3,220 ft. Initial output was 168 bbl. natural from an 80-ft. pay section, however the production improved to a daily rate of 381 bbl. Initial acidation of 250 gals. resulted in a flow rate of 883 bbl. a day on the basis of a four hour test. On being shut in and treated with 750 gals. of acid the well flowed 521 bbl. per day of clean pipe line oil, computed from an eight hour test. The well was given a productivity value of 520 bbl. of 26.3 deg. A. P. I. oil, by the Alberta Conservation Board. The oil flow was accompanied by gas volume which gauged 12,750,000 cu. ft. daily. It is situated on lands owned by the Canadian Pacific Railway Company.

Six additional tests have been staked or planned for immediate development of the Steveville structure. Standard Oil Company of British Columbia has started work for their Princess No. 3 in Legal Subdivision 5, Section 13-20-12w4. Anglo - Canadian Oils test is in the south half of Section 18-20-11-w4 and Dawson Syndicate has announced plans for a test in the north half of Section 18. A joint test will be drilled by Vulcan Oils and National Petroleum Company. Other tests will be started by Patricia Oils, Anaconda Oil Company and Royal Canadian Oil Company.

Formal recognition of the Steveville field was given by R. E. Allen, chairman of the Alberta Conservation Board in a statement issued during January which stated that "the production performance of this well to date together with its physical characteristics indicate that it is a commercial well and may accordingly be classified as the discovery well of a new oilfield. The board is, therefore, pleased to recognize No. 2 Princess as the discovery well of the Princess oil field and congratulates the Standard Oil Company of British Columbia for the discovery that has rewarded its faith in the oil prospects of Alberta, and John Galloway, geologist, whose knowledge and perseverance led to the discovery of this new field."

Drilling regulations covering development in the Princess field have been issued by the Alberta Conservation Board. The area is specified as Townships 19, 20 and 21, in Ranges 11 and 12 s of the Red Deer River. Permits for drilling are required and are to be limited to the odd-numbered LSD's of each section. Well spacing requirements restrict one well for each 80 acres, all wells to be staked in the center of a legal subdivision.

Del Bonita. Spurred by the success of Standard of British Columbia with discovery of commercial oil production at Steveville, coupled with the use of acidation, Trans-Alberta Oils has planned a test well east of No. 1 Terminals Oils at Del Bonita which has been producing light oils from the Upper Madison. Associated are H. M. B. Inglis who represented a group of lease-holding interests.

Thomas W. Leach who pioneered the present leasing campaign in North Dakota

Blood Indian Reserve. Potential possibilities of oil production from the Mississippian Madison limestone in other areas east of the foothills in southern Alberta is shown from results of a deep test at Blood Indian Reserve. Northwest-West Petroleums No. 1 encountered a fair showing of 36.5 gravity crude oil, free from water at a 20-ft. penetration in the Madison. First water showed at a 80-ft. penetration level; additional water was encountered 150 ft. in the formation. Late in February, this important test was drilling ahead below 6,440 ft. towards the Devonian limestone objectives.

MONTANA

Baker-Glendive Structure. Development of Paleozoic production on the Baker-Glendive anticline in Fallon county, Montana is the object of an exploration program on that major structure in progress since last summer by The Carter Oil Company, production subsidiary of the Standard Oil Company of New Jersey. Carter has signed a contract with the Fidelity Gas company, a wholly-owned subsidiary of the Montana-Dakota Utilities company to drill a 10,000 ft. test and develop the deeper horizons. Fidelity will receive 25 percent of the net returns of the development. Contract calls for commencement of drilling on or before May 1.

Decision to drill a deep test on this dome follows a geophysical survey of the Baker-Glendive regional structure during the past summer. Two oil wells have been completed since 1936 by the Montana-Dakota Utilities company from the Big Snowy group of Mississippian age, at depths of approximately 6,750 ft.

The Baker-Glendive program is a part of the regional exploration by the Carter initiated during 1940 throughout North Dakota, South Dakota and eastern Montana. Carter has employed the use of the reflection seismograph, the core drill, and the stratigraphic slim-hole rotary rig in their exploratory program.

The Cedar Creek gas field is productive of shallow gas from the Judith River formation of Upper Cretaceous age, in which reservoir 150 shallow wells have been completed with an aggregate volume of 40,000,000 cu. ft. daily.

The regional structure marks one of the outstanding geologic features of the Great North Plains basin. This asymmetric flexure extends in a northwest-southeast direction for a distance of approximately 100 miles through Fallon, Dawson and Wibaux counties in Montana, southeastward into Bowman county, North Dakota, terminating in Harding county, South Dakota. Paleozoic production was found during 1936 on Little Beaver dome which has a local surface closure of approximately 250 ft. as mapped on the Pierre shale of Upper Cretaceous age.

NORTH DAKOTA

Bottineau Gas Field. The oil and gas development history of North Dakota commenced during 1907 when gas production was struck at a rank wildcat test drilled nine miles south of Westhope in western Bottineau county in the great loop of the Souris river. While drilling a well for water, on the Parker farm, crews unexpectedly found a gas flow on July 8, at a depth of 178 ft. The wells found gas flows averaging 2,000,000 cu. ft. per day; the initial rock pressure was 75 lbs. per sq. in. and the thermal content was calculated at 886 B.t.u. per cu. ft.

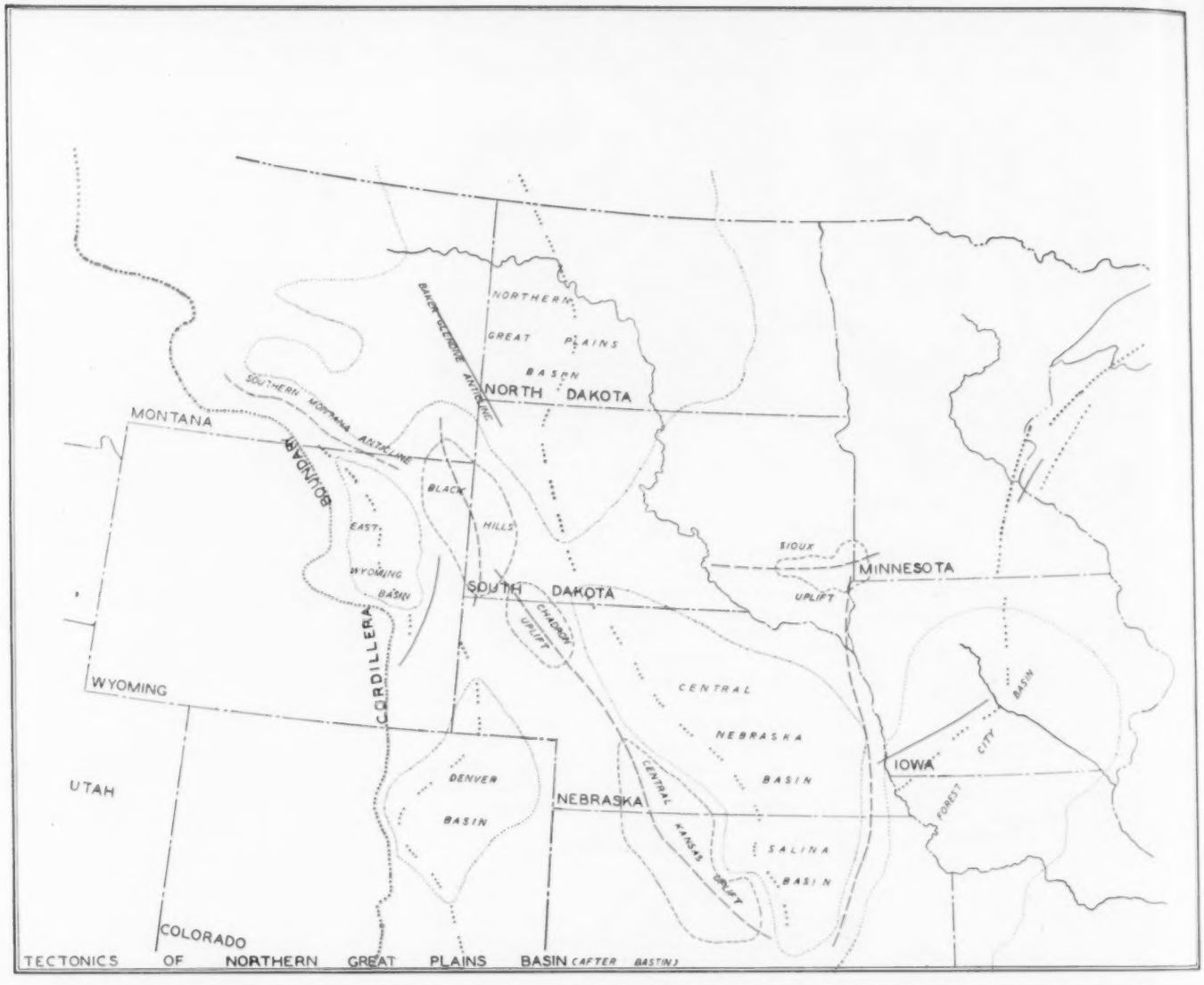
An analysis of the gas, which was prepared by Prof. E. J. Babcock of the University of North Dakota, showed a methane percentage of 82.7 percent and 12.4 percent of nitrogen; the complete analysis shows:

Gas	Percent
Hydrogen	0.5
Methane	82.7
Ethylene and other illuminants	0.2
Carbon monoxide	1.2
Oxygen	3.0
Nitrogen	12.4

The gas occurs in a layer of sand immediately underlying the drift at a depth of 154 to 200 ft. Sample examinations show it to be a medium fine-grained, rounded sand with a greenish-black color, due to an admixture of decomposing carbonaceous matter. The thickness of the sand, in which the gas was found, varies from 16 to 20 ft.

The gas discovery attracted much local interest and a large group of shallow wells were put down in Bottineau and Renville counties, largely by water-well machines. Gas flows were reported five miles west of the Parker farm at a depth of 200 ft. and at Maxbass, 16 miles southwest of Westhope, both localities being in Bottineau county; and at Lansford, 10 miles southeast of Mohall, and at McCashne, 14 miles southwest of Mohall, the latter tests being in western Renville county. The Great Northern Oil, Gas and Pipe Line company, which was formed to drill a deep test on the Parker farm reached a depth of 1,180 ft. found the discovery gas sand barren, and was completed in the Upper Cretaceous shales with no showings.

Eight producing gas wells were drilled by the North Dakota Gas company and from five of them, the fuel was piped to the town of Westhope, nine miles to the northward where



Tectonic features of the Northern Great Plains basin showing positive or anticlinal elements in red and negative or synclinal elements in blue.

it was used for lighting, heating and cooking.

Lansford Gas Field. Another small gas field was developed at Lansford in southwestern Bottineau county, shortly after the discovery at Westhope. A. G. Leonard of the United States Geological Survey, who investigated the area during 1909, reports that the initial casinghead rock pressures were from 62 to 74 lbs. and were sufficiently great to blow large quantities of sand from the hole together with pebbles and small boulders five to six inches to diameter. However, the rock pressure declined rapidly to 20 lbs. at which point, it remained for many months.

Production trouble was early experienced with the gas wells at both Westhope and Lansford, the fine sand clogging the well casings, so that the gas finally ceased to flow.

The Dakota sandstone was reached at a depth of 1,954 ft. in a test drilled on the Parker farm by the North Dakota Gas Company. Deeper drilling was abandoned on account of the small size of the casing at the bottom of the hole.

The gas area occurs within the known extent of glacial Lake Souris. Upham of the U. S. Geological Survey states that a glacial lake, known as Lake Souris, was formed upon the recession of the ice sheet from the Coteau du Missouri, lying between the Coteau and the southern border of the ice sheet. He describes the boundaries on the west extending from Hargrove and Elkhorn, Manitoba, on the Canadian Pacific Railway in a southerly direction to the international boundary at T. 164, R. 82 W. (U. S.) and then south to the vicinity of Minot, North Dakota. The Coteau du Missouri lies 50 miles to the southwest of the town of Upham in northern McHenry county and runs in a northwest-southeasterly direction.

John G. Barry of the State Geological Survey offered two theories on the origin and occurrence of the gas, as follows:

(A) The Upper Cretaceous sediments underlying the drift and the gas-bearing sand is a possible source; the gas may have formed within the shales and migrated into the overlying sand.

(B) The region received a deposit of detrital material with an admixture of organic matter (probably of vegetable origin). With erosion by the ice sheet, the area was covered with a mantle of thick, impervious drift deposit. The pre-glacial debris, subjected to decomposition of its buried organic material, would furnish an excellent reservoir for the accumulation of gas.

Barry's investigation of the region was made in September of 1908 and his report on the Bottineau gas field published shortly thereafter.

LaMoure County Gas Area. In the southeastern corner of North Dakota, a small shallow gas pool was developed prior to 1920 near the town of Edgeley, at depths ranging from 1,150 to 1,450 ft. from the Dakota sandstone. Gas from one of these wells supplied

Structure of the basements rocks of the Northern Great Plains basin with pre-Cambrian outcrops shown in red, contours in blue. (Datum-Sea level)

CONFIGURATION OF BASEMENT COMPLEX—NORTHERN GREAT PLAINS BASIN (AFTER MOSS, WILLIS)

part of the heat and power for the electric utility plant at Edgeley, while fuel from the others was used for domestic purposes by the farmers.

Deslacs Anticline. The Deslacs anticline, a minor low-pitching fold, lies at Deslacs 15 miles west and north of Minot in Ward county. Its axis trends north-northwest to south southeast, roughly parallel to the trend of the Deslacs river. Finding of gas at shallow depths on this fold encouraged deep exploration nearby. In 1919 the Deslacs Western Oil company was formed and a Dakota test drilled that year on the Blum farm in S. 4, T. 155, N., R. 85 W. The following geologic section was logged:

System	Formation	Top	Base
PLEISTOCENE:	Undifferentiated	0	60
EOCENE:	Fort Union	60	920
	Lance	920	1300
	Fox Hills	1300	1340
	Pierre Shale	1340	2820
U. CRETACEOUS:	Niobrara	2820	3400
	Benton	3400	3909
	Dakota	3909	3980 T.D.

Nesson Anticline. One of the more pronounced surface structures of North Dakota is the Nesson anticline, first mapped by A. J. Collier, of the U. S. Geological Survey, who in mapping lignite coal beds near Ray, noticed important dips in strata outcropping on the side of buttes.

The structure lies in southeastern Williams county and northeastern McKenzie counties, and strikes northwest to southeast. As mapped by the United States Geological Survey, it is a broad, low-dipping anticline, covering portions of townships 152, 153, and 154 North, and ranges 95, 96 and 97 west. It is 13 miles southeast of the town of Ray, 80 miles west of Minot, and 30 miles east of Williston. A well drilled for artesian water several miles west of the crest of this anticline was reported to have struck a flow of gas at a depth of 750 ft

The Nesson anticline was discovered in 1917 by a party of United States Geological survey field men who were mapping outcrops of lignite beds in the Ray quadrangle.

On the basis of Collier's report, a local company was formed in 1926, known as the Big Viking Oil company. A well drilled on this anticline using cable tools, reached a depth of 4,700 ft. the following year; a showing of gas was logged at 4,300 ft. Drilling was suspended after operators exhausted available capital.

The California Company, producing subsidiary of the Standard Oil Company of California was attracted to the area, both from the report of Collier and the showing in the Big Viking test. Contract was signed with Manning and Martin, Inc., Tulsa, Oklahoma, drilling contractors to put down a 10,000-ft. test. A heavy duty rotary rig was moved to a drill site only a few hundred yards from that of the Big Viking Oil Company, in section 3, T. 153 N., R. 96 W., in Williams county.

SOUTH DAKOTA

Barker Structure. Early search for oil and gas production in South Dakota centered around the Black Hills uplift in the extreme far western portion of the state. Shallow drilling on the flanks of the uplift has been spasmodic for the past 20 years, but the first commercial well to be discovered in the state was drilled during December of 1929 on the Barker structure in Custer county. The first oil well, drilled on the south flank of the Black Hills uplift, was that of the Black Hills Petroleum company No. 1 Barker, which was completed for six barrels of black, lubricating oil per day from a depth of 1,328 ft. in the Minnelusa sand. A distillation analysis of the crude oil taken from this well shows 20 percent gasoline, 17 percent kerosene with a high grade of lubricating stock. The well was drilled on a surface structure mapped by C. T. Lupton, Denver, Colo. geologist.

Elm Springs Structure. Considerable interest was attached to the deep test drilled on the Elm Springs structure on the east flank of the Black Hills uplift in Meade county, South Dakota by the old Gypsy Oil Company now the Gulf Oil Corporation. Their No. 1 Hunter, in S. 28 T. 3 N., R. 13 E., encountered a showing of oil in the Lakota sand series of the Lower Cretaceous found at depths of from 3,178 to 3,520 ft. The well was carried deeper and found fresh water in both the Lakota and in the base of the Morrison formation from 3,560 to 3,630 ft. A gas showing was encountered in the Minnelusa formation topped at 4,282 ft., but deeper drilling in this formation found more fresh water. It was completed as a dry hole at a depth of 5,211 ft. in the Englewood limestone of Mississippian age topped at 5,134 ft.

Camp Crook Anticline A showing of oil was encountered in the top of the Deadwood formation at a depth of 7,820 ft. (according to scout reports) in a deep test abandoned during 1940 on the Camp Crook anticline. The structure, lying en-echelon to the Cedar Creek (Baker-Glendive) anticline, has 400 ft. of closure as mapped on the Pierre shales of Upper Cretaceous age. The test well was States Royalty Petroleum, Inc., No. 1 State, in the center southwest northeast quarter of Sec. 35, T. 18 N., R. 1 E. in Harding County. It was drilled to a total depth of 7,918 ft. in the Deadwood formation.

GAS PRODUCTION

A belt of shallow gas production from the Dakota sandstone (Cretaceous age) occupies an area in central and north-central South Dakota. This gas, produced with artesian water, occurs on a broad structural terrace (as mapped on top of the Dakota sandstone) on the southeast flank of the so-called Lemmon syncline flanked by the Sioux uplift on the southeast and the Black Hills uplift on the southwest. Distribution of this gas ranges from structural levels as high as 500 ft. above sea level to as low as 200 ft. below that datum. Greatest number of gas wells producing from the Dakota sandstone in this state are found in Walworth, Potter, Haakon and Stanley counties, with fewer wells recorded in Sully, Armstrong, Hyde, Hand, Campbell, Jones, Lyman, Ziebach, Dewey, and Hughes counties. Dr. E. P. Rothrock, Pierre, State Geologist of South Dakota, states that structural slopes as gentle as only 10 ft. to the mile prevail between the top of the terrace and the synclinal axis, but on the terrace proper flatten out to three to four feet per mile.

Gas has been produced from artesian wells along the front of this terrace for more than 40 years. A small commercial supply has been furnished from Dakota sandstone wells to the cities of Fort Pierre and Pierre. Large ranch houses and federal Indian schools are provided with both light and fuel from this gas horizon.

Gas Sample From Dakota Sandstone in Stanley County, S. D.

Lacy gas well. Section 35, Township 7 North, Range 28 East.

Constituent	Percent
Carbon dioxide	3.1
Oxygen	0.6
Methane	88.7
Ethane	0.0
Nitrogen and helium by difference	7.6
Total	100.0
(Helium content	0.4)

Analysis prepared by the U. S. Bureau of Mines, Oil and Gas Laboratory, Amarillo, Texas, furnished by E. P. Rothrock, Pierre, South Dakota, State Geologist of South Dakota.

LEASING

More than 8,000,000 acres of oil and gas leases has been taken in both North and South Dakota since the Williston basin leasing play started in the fall of 1939. Earliest to enter the area was the Thomas W. Leach, prominent Tulsa geologist and operator, who first worked in North Dakota during 1938 while employed by the Transcontinental Oil Company. At the time, he checked the area in the vicinity of Minot in Ward county on the basis of the shallow gas development in both the glacial drift, and in the Pierre shales of Upper Cretaceous age. Leach's report was unfavorable.

The following year, after leaving the Transcontinental, Leach together with Ray V. Hennen, formerly with the West Virginia Geological Survey and one-time chief geologist for Transcontinental, reentered the North Dakota area and reworked the Nesson anticline in Williams county. The partnership leased four blocks in Mercer, Morton and Oliver counties as follows:

MERCER: Beulah block, 30,000 acres
OLIVER: Price block, 47,000 acres
Hanover block, 50,000 acres.
MORTON; St. Anthony block, 100,000 acres.

These were taken largely during 1939 and early in the following year, Leach and associates turned over to Carter Oil Company all four blocks comprising 227,000 acres.

Kerlyn Oil Company, of Oklahoma City, was one of the first Oklahoma companies to carry on geological exploration immediately preceding the new lease play. D. A. McGee, vice-president in charge of geology and production sent Al Wynn, district geologist to the area in September of 1939. Wynn worked surface structure in North Dakota throughout the following year on which basis Kerlyn acquired considerable acreage.

One of the most persistent leasing programs carried on by an independent group of operators is that by Bradley Brothers, Birkett & Gillespie, and associates of Wichita, Kansas. The group signed up 150,000 acres during 1940 in Mercer, Morton, Oliver, Emmons and Sioux counties of North Dakota. The acreage was taken on the basis of surface structural data.

Carter Oil company led in the leasing

activity in North Dakota during 1940 taking two blocks in McLean county, and other blocks in Emmons county.

Magnolia Petroleum Company, of Dallas, Texas, subsidiary of Socony-Vacuum Oil Company, Inc., has checkerboarded the district since July of 1940. Barnsdall Oil Company has checkerboarded in Morton and Oliver counties.

Counties receiving the greatest leasing attention were Morton, Burleigh and Oliver counties. Other areas drawing considerable interest were Mercer, Emmons, Ward, Sioux, and McLean counties.

Carter Oil Company and Magnolia Petroleum Company carried on extensive leasing in South Dakota during all of 1940 following the Williston basin play. Carter employed surface, structure, stratigraphic tests, core drill, gravimeter and reflection seismograph in conjunction with selecting areas for leasing and checkerboarding.

Largest single landowner in the area around Pierre, South Dakota, is the South Dakota Rural Credit Board. In December, 1940, it reported that it had sold more than 600,000 acres in an area 125 miles square including Haakon and Ziebach counties. During one week in December, more than 100,000 acres were leased from this board.

LEASING SUMMARY NORTH DAKOTA

(Report as of February 1, 1941)

Country	Percent Leased	Type of Leasing	Active Companies
McLEAN	50	C, C	Carter Oil Company Thomas W. Leach (2 blocks)
MORTON	80	C	Barnsdell Oil Company, Bradley Brother L. F. Hansa, Wichita, Kansas.
MERCER	40	B	Thomas W. Leach (2 blocks), Bradley Bros.
BURLEIGH	45	C	
EMMONS	50	C	Carter Oil Company, Bradley Brothers
SIOUX		C	Bradley Brothers
WARD	15	B, C	Magnolia Petroleum Company
OLIVER	70	B	Barnsdell Oil Company, Thomas W. Leach (2 blocks) Bradley Brothers

a "B" means blocking; "C" means checkerboarding
b Largely Indian reservation land.

GEOPHYSICS

Success of the use of the reflection seismograph in delineating local structure in the Northern Great Plains basin is indicated from the recent oil discovery in the Princess (Steveville) field in Alberta. W. R. Ransome of the Geophysical Service, Inc., states that "we have worked in Montana, North Dakota, Alberta and Saskatchewan, and on the whole, believe that our work was quite satisfactory. Proof of this is the newly-discovered Princess (Steveville) field in Alberta. The amount of geophysical work done in each area is in the following decreasing order: Alberta North Dakota, Montana and Saskatchewan.

The reflection seismograph was employed in detailing structure on the Nesson anticline in North Dakota during 1937 by The California Company (subsidiary of Standard Oil Company of California) who engaged the GSI for the survey.

During December, 1940 a seismograph crew of Carter Oil Company which had been operating near Mandon in North Dakota, cut short their work for the winter period. Likewise, another Carter seismograph crew operated in the Pierre, South Dakota region mapping structure in the southeast flank of the Lemmon syncline.

Kerlyn Oil Company of Oklahoma City has employed an independent reflection seismograph crew in the Dakotas, but used its own magnetometer crew in exploration throughout that district.

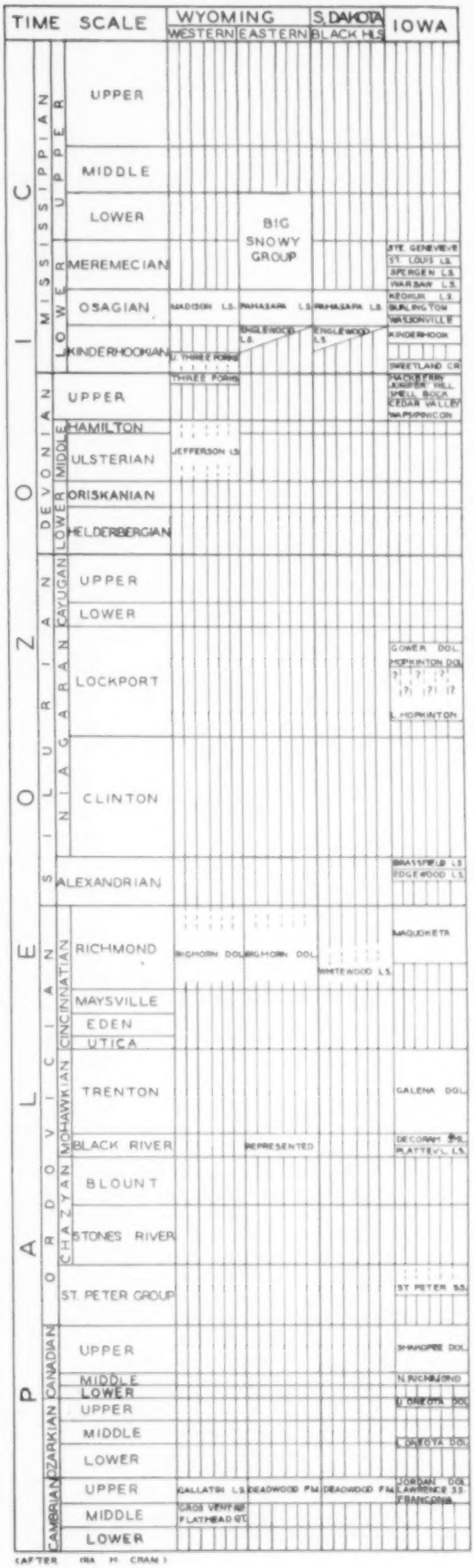
Ohio Oil Company made seismograph surveys in the Dakotas during 1940, using an independent crew.

Southern Plains Area. Marked success of the use of reflection seismograph geophysical surveys in the Southern Plains area has been pointed out by G. S. Hume, who explains that the sharp contrast provided by the dense Paleozoic limestones (overlain by the Mesozoic sediments consisting of sandstones and shales) provide a good seismic reflecting surface. He states that "it has been found feasible to outline the structural features of the limestone surface lying at depths of thousands of feet."

Saskatchewan. An exploration project covering both geophysical surveys and deep drilling for southeastern Saskatchewan has been recently announced by Hon. W. F. Kerr, minister of natural resources for Saskatchewan. The undertaking, estimated to cost more than $150,000, follows a recent agreement between the Nereanols Oil & Gas, Ltd., and the provincial government. More than 1,800 square miles will be included in the surface geological survey. Reconnaissance will be followed by geophysical exploration including the use of both the gravity meter and the reflection seismograph methods. Development is projected for a period of at least two years. The area lies due north of the Williston basin where a 10,281-ft. Paleozoic test was drilled in 1938 by The California Company.

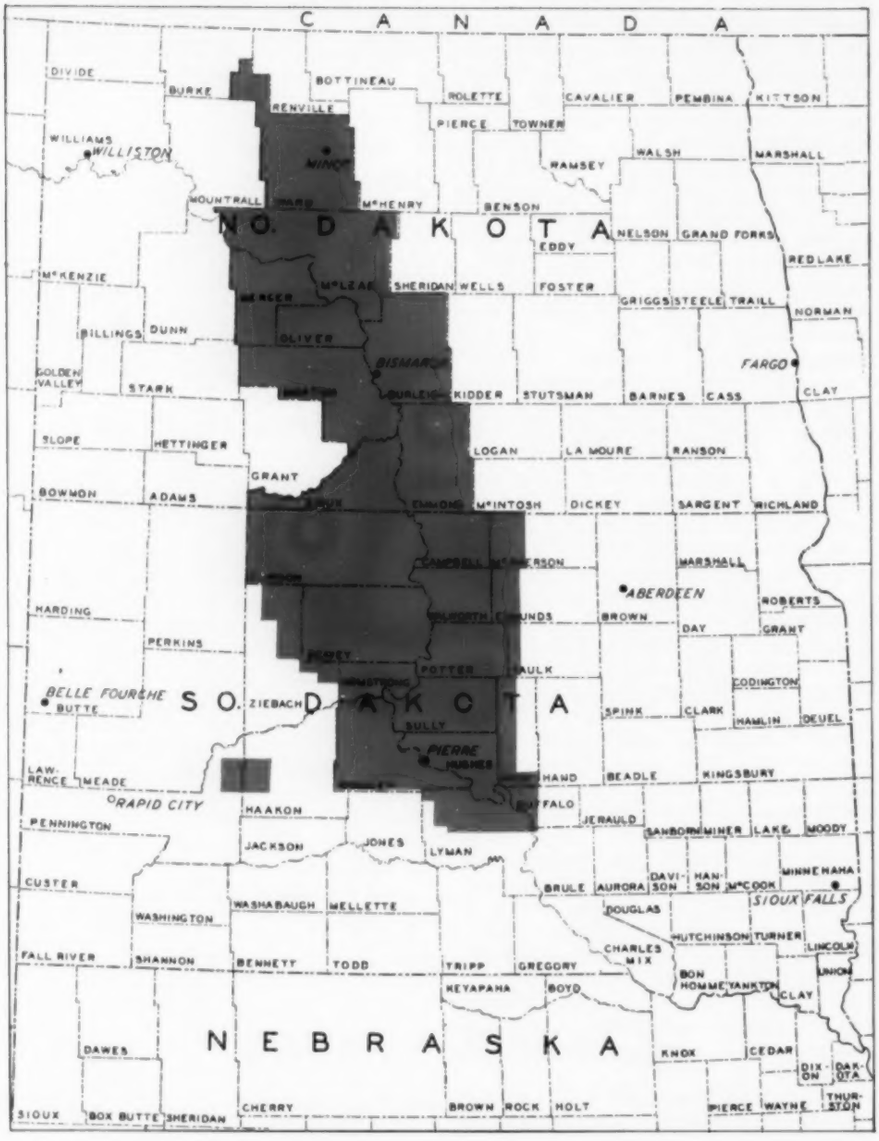
The first wildcat test drilled on a gravity meter-magnetometer survey in Montana was drilled during July, 1939 eight miles northwest of Grandview postoffice in Toole county. It was a standard tool test drilled by Coolidge & Coolidge at their No. 1 Forseth in S. 8 T, 35 N. R. 3 E.

Blood Indian Reserve. One of the most promising geophysical prospects in the southern plains of Alberta for development of Madison lime production is at Blood Indian Reserve southwest of Lethbridge. Considerable south closure on the north-plunging Sweet Grass Arch is indicated from reflection seismograph surveys. The first deep test drilled on this feature encountered some saturated sections in coring to 6,141 ft. in the upper Madison formation at Northwest—West Petroleums 1 LSD 3, 20-5-23w4; however the initial drill-stem test was inconclusive and a further test is being made. Failing to develop production in this formation, it will be carried to the Devonian.



Correlation chart of Paleozoic sediments represented in South Dakota and Wyoming, with reference to the standard New York section and the Iowa state section.

(AFTER IRA H. CRAM)



Map of North and South Dakota with areas of leasing activity indicated in red.

Del Bonita. Excellent results from acidation of the Madison formation in the new Princess field (Steveville area) in Alberta, has revived exploration in the Del Bonita shallow light-crude field in southern Alberta near the International Boundary. Consequently, Trans-Alberta Oils together with H. M. B. Inglis lease interests have made plans for a test well east of No. 1 Terminal Oils, which is producing light oil from the upper Madison. Del Bonita produced 2,365 bbl. of oil during 1939, and 3,246 bbl. during 1940.

Stratigraphic Drill Holes. Carter Oil Company of Tulsa, Oklahoma, producing subsidiary of the Standard Oil Company of New Jersey, drilled during 1940 four stratigraphic test holes in the Great North Plains basin. Two of these were drilled in North Dakota, one in Emmons County (T. 132 N., R. 76 W.) and the other in Morton County (T. 136 N., R. 83 W.) The two other stratigraphic test holes were drilled in Potter County (T. 118 N., R. 78W.) and in Stanley County, near Ft. Pierre, South Dakota.

STRUCTURE

Black Hills Uplift. N. H. Darton and Sidney Paige, in "Geologic Atlas of the United States," described the Black Hills uplift as an irregular dome-shaped anticline, embracing an oval area 125 miles long and 60 miles wide. It was formed in a wide expanse of nearly flat beds, the uplift bringing above the general plains level a mass of Algonkian schists, conglomerate, quartzites, limestones, granites and associated rocks. Around this mass there is upturned a nearly complete sequence of sedimentary rocks ranging in age from Upper Cambrian to latest Cretaceous, all of which dip away from the central core. Structure on the flanks of the uplift is essentially monoclines that dip towards the plains.

Greatest vertical displacement of the Paleozoic beds, as indicated by the present elevation of the granite floor is approximately 9,000 ft. Most of the subordinate flexures are featured by steep dips on their western slopes, merging into the principal dome in one direction and featuring a declining pitch in the other direction. One of the most notable structural irregularities of the uplift is the sharp deflection of the dome to the northwest. Several small anticlines occur. Numerous local domes and flexures feature the Northern Black Hills, due principally to laccolithic igneous intrusions. The most prominent of these intrusions is that of Bear Lodge Range. Faulting is rare on the uplift, except in areas where igneous masses have distorted the beds vertically.

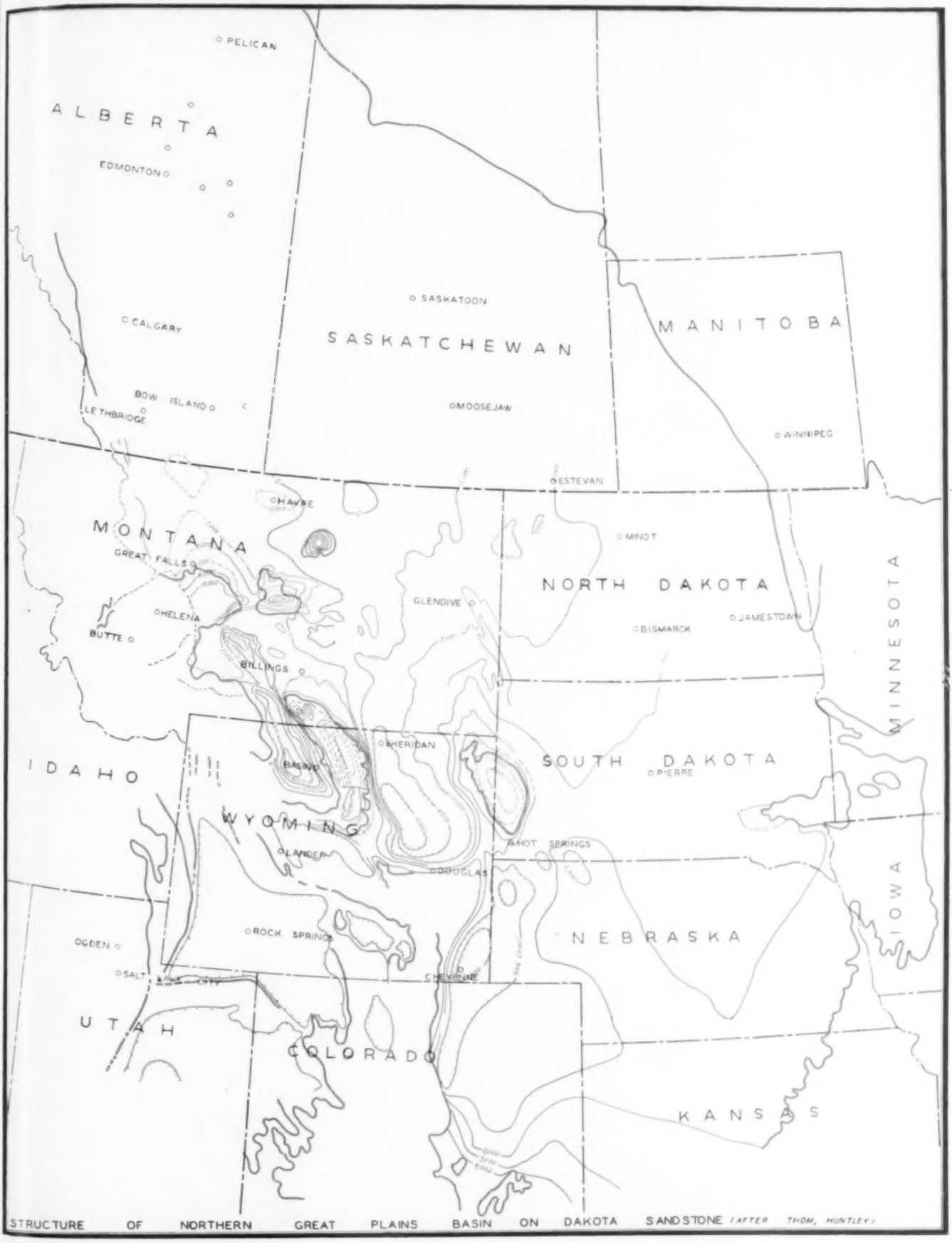
Angle of dip on the flanks of the Black Hills is less than 20 degrees, referring to the attitude of the beds from the Cambrian to the Cretaceous. In the plains east of the Black Hills, the rate drops to less than five degrees. Intrusions of igneous masses (Bear Butte) and the laccoliths south of Spearfish, Sturgis and Deadwood, have interrupted the monoclinal structure of the slopes of the uplift; these have formed local flexures or faults.

Sioux Arch. The Sioux arch, as described by Rycroft G. Moss, "Buried Pre-Cambrian Surface in the United States", (Bull. Geol. Soc. Amer.,Vol. 47, page 963), is a low broad arch, projecting southward from the Canadian Shield, between the Williston and Minnesota basins. The localized Sioux Uplift comprises an inlier of pre-Cambrian quartzite (Sioux quartzite) in southeastern South Dakota and adjoining parts of Iowa and Minnesota. A saddle in central western South Dakota separates this arch from the Black Hills.

The Sioux Arch, forms the major portion of the old landmass called Siouxia. Occurrence of Ordovician limestones on both sides of the uplift suggests that these deposits originally covered the arch. The old landmass has been a relatively quiescent area since early Paleozoic time, and probably was never raised to a high elevation. The widespread Cretaceous seas deposited considerable sediments over most of the arch. A large subsurface basin centering in west central North Dakota near the town of Williston is the major feature known as the Williston basin. It includes the northward plunging Lemmon syncline lying northeast of the Black Hills, and the Carrington syncline which plunges westward in central North Dakota.

The Williston basin is interrupted by two important structural features which may be fault scarps in the pre-Cambrian basement rocks. The Baker-Glendive anticline, an asymmetrical anticline trending northwest to southeast, crosses southeastern Montana,

Structure of the Northern Great Plains basin contoured on top of the Dakota sandstone (Cretaceous) as shown by light red lines, with outdrop of the Dakota in heavy lines and faults and flexures by broken heavy lines.



STRUCTURE OF NORTHERN GREAT PLAINS BASIN ON DAKOTA SANDSTONE (AFTER THOM, HUNTLEY)

southwestern North Dakota, and terminates in northwestern North Dakota. Another major fault suggested in the pre-Cambrian basement from geophysical exploration lies in eastern Williams County, North Dakota, near the heart of the Williston basin. The fault is probably genetically related to the deep-seated structural movement that resulted in the Baker-Glendive (Cedar Creek) anticline and a series of en-echelon faults that extend northward from the Black Hills uplift.

Baker-Glendive Anticline. One of the outstanding structural features of the Great North Plains basin is the Baker-Glendive or Cedar Creek anticlines occupying portions of Dawson, Fallon and Wibaux counties, in eastern Montana, Bowman county in southwestern North Dakota, and Harding county in northwestern South Dakota.

The structure is asymmetrical, extending in nearly a straight line for a distance of more than 115 miles in a northwest-southeast direction. Apparently, the fold overlies a fault scarp in the pre-Cambrian basement complex, being genetically related to a series of en-echelon folds and faults extending northward from the Black Hills uplift roughly parallel to the Cordilleran boundary.

This feature is prominent on areal geologic maps comprising an elongated inlier of Cretaceous Pierre shale outcropping in younger blanket of Eocene rocks. Few faults have been mapped in the Pierre outcrops. Shallow gas production has been developed from the Pierre shales on Gas City dome, Cabin Creek dome, Baker dome, all in the Montana portion of the anticline. Paleozoic oil production has been discovered from two deep tests on Little Beaver dome a few miles west of the North Dakota-Montana state boundary line (see structure map of Cedar Creek anticline elsewhere in this report), from the Big Snowy group of Mississippian age. Other Paleozoic development is anticipated on this structure this year.

Lewis Fault. The outstanding structural feature of Alberta is the Lewis thrust fault in southern Alberta, trending N. 30 deg. W. Formations along this zone have been thrust plainsward for a distance of 15 miles. Lying between this fault and the Alberta syncline paralleling the Rocky Mountain front is a disturbed belt occupying a zone of from 10 to 25 miles in width, traceable the entire length of the Canadian portion of the front. The belt is one of thrust faulting and intense low-angle folding, with the fault planes dipping steeply to the west. The eastern boundary of the disturbed belt is marked by the presence of Tertiary sediments and the lack of faulting. Structures in this belt, parallel the strike of the Lewis thrust fault, except in the northeastern part where they swing to N. 50 deg. W, and N. 60 deg. W.

Kevin-Sunburst Dome. In northern Montana, adjacent to the International Boundary lies the prominent Kevin-Sunburst dome, occupying the highest structural position on the Sweetgrass arch. The feature, circular in outline, has a diameter of about 25 miles and a structural closure of at least 700 feet according to C. E. Michener, in the Jour. of Geol. (Vol. 62, No. 1, pp. 56-57). It is productive in the Madison limestone of Mississippian Osage Age.

Sweetgrass Arch. The Sweetgrass arch is a broad fold on the continental side of the Rocky Mountain front in eastern Alberta and Montana, a characteristic of North American structural geology, duplicated in the Appalachian geosyncline. It extends for a length of 200 miles and the width of the arch varies from between 40 and 70 miles. From its crest in the Little Belt Mountains, it trends west of North into southern Alberta, swinging northeast towards the city of Medicine Hat where it loses its identity.

Earlier known folding of this positive element occurred between the long hiatus that separated the Mississippian and the Jurassic. However, the arch received its major uplift at the close of the Cretaceous during the Laramide Revolution which developed the Rocky Mountains; folding was increased to the south and the entire arch was tilted northward, cancelling the earlier south plunge.

In describing the present attitude of the Sweetgrass arch, Michener states that it plunges N. 10 deg. W, from the top of the Kevin-Sunburst dome in northern Montana to a point 30 miles north of the International boundary in Alberta, dipping at the rate of 44 ft. to the mile northward.

The dip varies from a few feet on the crest of the fold to as much as 200 ft. to the mile where it dips westward into the Tertiary-filled Alberta syncline.

Northwestward plunging terraces form the most prevalent type of local folding. Associated with the Sweetgrass Arch is a high-angle normal tensional fault on the eastern flank of the fold at Cypress Hill. Here it trends approximately parallel to the main axis, and its greatest displacement is about 500 ft. with the downthrown side to the east

Action of strong compressive stresses from the west, in at least the upper part of the sedimentary section (Upper Cretaceous) is reflected in a sheared zone on Oldman River in Sec. 31, T. 9, R. 23 W. Here a series of 14 small reverse fault blocks are compressed in a strip only one mile in width. The fault planes are inclined to the west at high angles ranging from 50 deg. to 60 deg. while the entire sheared zone trends N. 15 deg. E. The Fox Hills sandstone (a widespread horizon marker between the continental St. Mary River sandstone and the marine Bearpaw shales) is repeated in nearly every fault block, for the most part dipping steeply to the west.

Although the igneous plugs in Montana, known as the Sweetgrass Hills are not properly a portion of the Sweetgrass Arch, they prove that the greatest uplift is associated with igneous intrusions of local extent.

Truncation not only is widespread over the Alberta portion of the arch, but south of the International Boundary in Montana, the Madison section has been eroded 400 ft. over the crest. This is referred to by W. F. Howell, in "Structure of Typical American Oil Fields", Amer. Assoc. Petrol. Geol.

An important factor in the post-Madison development of the Sweetgrass Arch is the slow recurrent uplift which was concurrent with deposition. The weathered surface of the truncated, beveled Madison is reflected in the cavernous nature of the formation, coupled with the presence of iron and chert as shown from test wells. This also proves that the Madison was base-levelled prior to the deposition of the shallow-water Jurassic Ellis on the relatively low topographic relief.

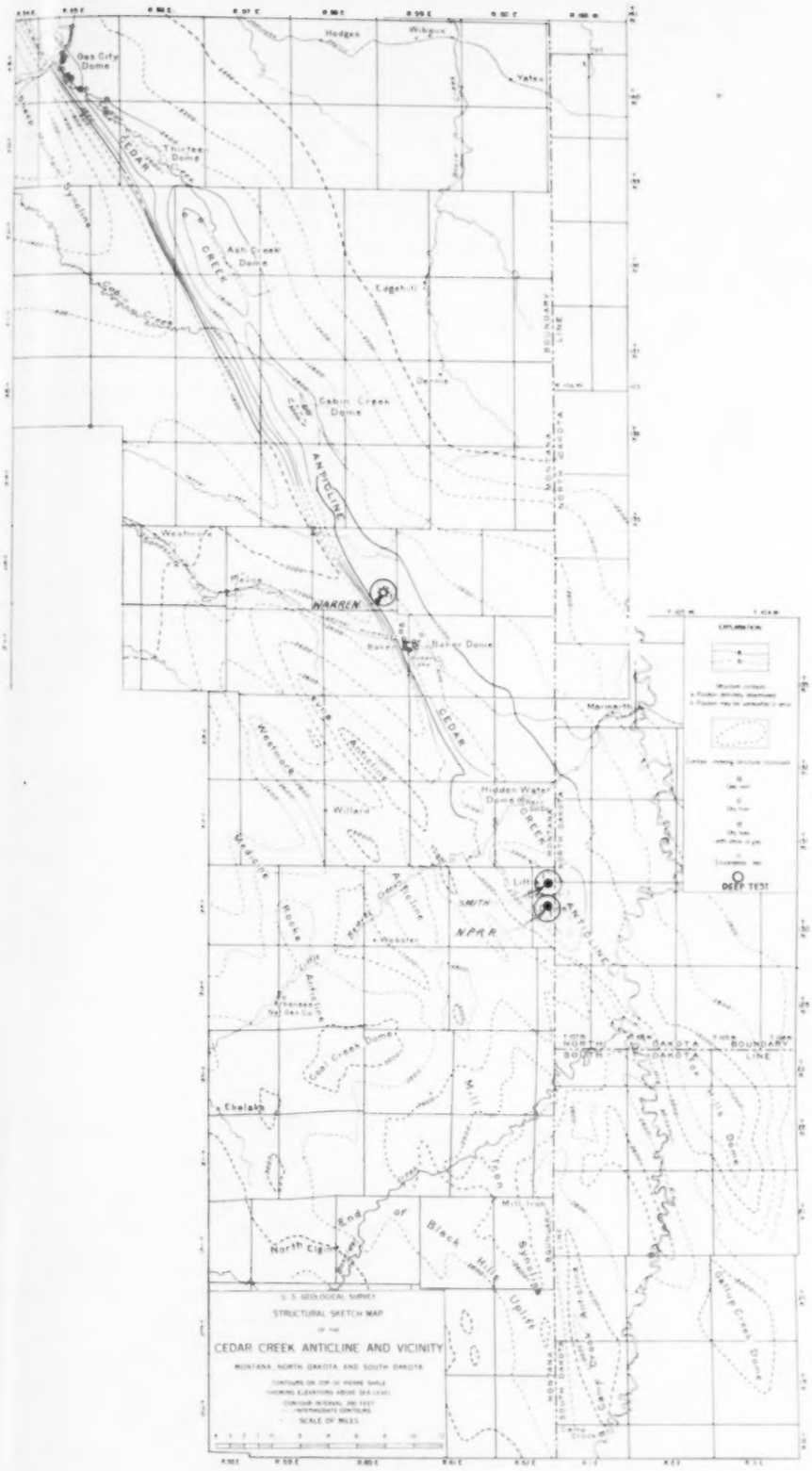
Initial folding of the arch was produced probably by vertical stresses, and vertical forces also controlled the final folding.

The Paleozoic aspects of the Sweetgrass arch is one of a southward plunging arch, featured by regional peneplanation so that lower and lower Paleozoic horizons are truncated northward, as described by P. D. Moore in the Bull. of A. A. P. G. (Vol. 15; No. 10, 1931). As cited elsewhere in this report, the Sweetgrass arch was a topographic prominence in pre-Jurassic (Ellis) time and subsequent truncation and base-levelling removed considerable Madison dolomite from the crest of the structure. Success of the Standard Oil Company of British Columbia with the seismograph at Princess (Steveville) in developing the Paleozoic oil reserve in this field presages wider use of this geophysical method for the Paleozoic objective along this broad fold.

Michener concludes that renewed uplift of the Sweetgrass arch took place during Ellis (Jurassic) to Virgelle (Upper Cretaceous) time, suggesting the work of vertical adjustments. This has important bearing on both Paleozoic and Mesozoic oil possibilities. Paleographic studies of the Lower Mesozoic and the Upper Paleozioc will prove useful in both stratigraphic studies and in the search for stratigraphic traps on local structure.

Alberta Syncline. One of the pronounced structural features in the northern portion of the Moose Jaw synclinorium is the Alberta syncline. G. S. Hume, in describing this feature, points out that post-Cretaceous beds occupy the central part of the syncline which extends in a relatively large area from Lesser Slave Lake southeastward to the International Boundary, but east of the complicated zone of faulting and folding in the foothills belt. On the south, the syncline is narrow where it is bordered by the Sweetgrass Arch on the east. Although no closure is shown on the south for the Sweetgrass Arch in Canada; however, subsidiary folds have been developed on the arch itself, and to the west on the east flank of the Alberta syncline.

Regional Truncation. Throughout southern Alberta and Montana, a major hiatus of the first magnitude is represented by the middle Mesozoic overlying middle Paleozoic rocks. The widespread disconformity at the base of the Jurassic is one which represents major regional truncation. This is proven by the overlap of Jurassic onto Mississippian, Pennsylvanian and Triassic in



Surface structural map of the Cedat Creek or Baker-Glendive anticline of southeastern Montana, southwestern North Dakota and northwestern South Dakota. Large well circles indicate deep Paleozoic development. Map published through the courtesy of the United States Geological Survey.

the foothills on the eastern border of the Rocky Mountain front. At the north edge of the Moose Jaw synclinorium, Cretaceous rests directly on Upper Devonian, on Clearwater River and on the Mackenzie and its tributaries, according to Theodore A. Link in A. A. P. G. Bulletin (Vol. 15, No. 5, 1931). Eastward the Lower Cretaceous lies on Upper Devonian at the Manitoba escarpment. Planation was progressively deeper into Paleozoic sediments in a northeasterly direction. The regional extent of this truncation and the various strand lines which are far from concentric offer a wide range of stratigraphic traps important for possible oil and gas reservoirs.

Local Truncation. The most prominent structural feature in the plains of southern Alberta is the northward-plunging Sweetgrass arch. P. D. Moore explains that there is a pronounced truncation of upper Madison beds from the top of the Sweetgrass arch that are present on the flanks, proving that the fold was still a prominent feature even in pre-Jurassic time. This is especially true on the western flank where several hundred feet of upper Madison are present in the downwarped area of the Alberta syncline that were truncated from the crest of the arch.

Saskatchewan-Manitoba. Paleozoic strata of the Manitoba lowland dip gently southwest from the edge of the Canadian shield. The Manitoba escarpment represents a true cuesta in which the beds dip away from the escarpment face; west of the escarpment, they are covered by Mesozoic strata.

In southwestern Saskatchewan, there is a broad basin, in which the Mesozoic strata are overlain by Tertiary beds, which is described by G. S. Hume, in "Oil and Gas in Western Canada."

In the Regina area, two periods of folding have taken place—one in pre-Certaceous time, the other in post-Cretaceous.

STRATIGRAPHY

Paleozoics. The Paleozoics overlap the Pre-Cambrian of the Canadian Shield, and occupy the whole of the Manitoba lowland and large areas within the Mackenzie lowland. These outcrop extensively among the folded and faulted strata of the eastern ranges of the Cordillera. Although Paleozoic beds underlie the younger strata of the plains throughout the Moose Jaw synclinorium and other basins of the Rocky Mountain province, the section and age relationships vary from place to place. The comparatively few outcrops of the Paleozoics along the borders of the region make correlation difficult.

Shoshone. The Lower Paleozoic system on the west side of the Northern Great Plains basin, is well developed in western Wyoming, particularly where it is exposed in Shoshone Canyon just west of the town of Cody in Park county, since it represents an essentially conformable though discontinuous sequence from the Middle Cambrian upwards. In this locality, the Shoshone river has cut a canyon

3,000 ft. between Cedar and Rattlesnake mountains. Shoshone Canyon is geologically described by G. Duncan Johnson in the Jour. of Geol. (Vol. 62, No. 1).

The Paleozoic marine series at Shoshone canyon consists roughly of 60 percent limestones and dolomites, 25 percent shales, and 15 percent sandstone. No rocks are believed to be present to represent the Lower Cambrian, Lower Ordovician, Silurian of Lower Devonian. The Upper and Middle Cambrian at Shoshone Canyon have been grouped into the Deadwood formation in the Big Horn Mountains by Darton.

Middle Cambrian. The Middle Cambrian at Shoshone Canyon is represented by the Flathead sandstone which Johnson describes as a "brownish, indurated sandstone or quartzite with lenses of very coarse sandstone of fine quarta conglomerate", and stresses that no persistent, basal conglomerate overlies the pre-Cambrian surface. Overlying the Flathead sandstone is the Gros Ventre formation which is composed largely of shales and thin-bedded sandstones including beds of nodular limestone.

Upper Cambrian. The Gallatin limestone represents the Upper Cambrian at Shoshone Canyon. Intraformational conglomerates feature the Cambrian in this locality, particularly a flat-pebbly limestone conglomerate occurring in the upper Gros Ventre, but especially characteristic of the Gallatin. It comprises a series of massive limestone, thin-bedded limestones, with calcareous shales and dolomitic limestone with some nodular beds.

Upper Ordovician. Overlying the Gallatin limestone is the Bighorn dolomite of Upper Ordovician age. At Shoshone Canyon, is is principally massive, buff and gray dolomite, with thin beds of sandstone and white, chalky dolomitic beds. The top of the formation is marked by a single occurrence of reddish limestone.

Upper Devonian. The Three Forks formation representing the Upper Devonian overlies the Bighorn dolomite. Essentially, it is a series of soft, orange-buff limestones and yellow-green shales which have been correlated with the Three Forks formation by Tomlinson and Lovering.

Lower Mississippian. The Madison limestone of Lower Mississippian age overlies the Three Forks formation. Johnson states that the Madison at Shoshone Canyon shows little variation in general lithology; that there is irregular distribution of minor features as solution cavities, coral-reef limestone and brecciation from bottom to top, stressing the lack of persistent fossil horizons, notwithstanding that the entire formation is noticeably fossiliferous. A thickness of 900 ft. is the approximation set forth by that author.

The Amsden formation was named by N. H. Darton in 1904 from its exposures along a branch of Tongue River west of the town of Dayton, Wyoming. There, the Amsden consists of those beds that occur between the top of the Madison limestone and the base of the Tensleep formation.

Mississippian age is assigned the Amsden of the Wind River Mountains by E. B. Branson and D. K. Greger, although it was originally considered Pennsylvanian by Darton. They concluded from faunal evidence correlation with Ste. Genevieve.

Lithology of the Amsden formation in north-central Wyoming and south-central Montana is described by Harold W. Scott, as consisting of two zones, an upper limestone member; and a lower red magnesium shale or sandstone.

In these areas, the predominant color of the lower member is red; its thickness is 100 ft. At Cinnabar Mountain, north of Gardiner, Montana, the lower member is 130 ft. thick, but decreases in a northerly direction so that at Eustis, five miles north of Three Forks it is only 25 ft. thick where it is composed entirely of coarse, red sandstone. Conglomerates, derived from the underlying Madison are common to the base of the Amsden, but are very thin and lenticular in occurrence.

In south-central Montana, the limestone member of the Amsden formation is blue gray, and thinly-bedded; its thickness ranges from 30 ft. near the Wyoming-Montana boundary line to 200 ft. in the Lombard Hills north of Three Forks.

Paleontological proof of the existence of considerable thicknesses of the Big Snowy group in eastern Montana, particularly in deep tests drilled on the Baker-Glendive anticline is mentioned by DeWolf and West in the A. A. P. G. Bulletin (Vol. 23, No. 8, 1939) who call attention to "the presence of Mississippian beds younger than the Madison and older than the so-called Amsden which exist in eastern Montana with a thickness comparable with that of the Big Snowy group. The fossil evidence is consistent with this interpretation but is insufficient at present to justify a detailed correlation with the subdivisions of the Big Snowy group in the type locality". They also stress that "although an unconformity exists in the Big Snowy Mountains in central Montana, at the top of the Madison formation (underlying the Big Snowy Group), in central Montana and elsewhere, it is entirely possible that none is present at Baker (Baker-Glendive anticline) and that deposition was continuous, or only mildly interrupted from the Madison to the Kibbey (member of the Big Snowy Group).

Age assigned by Harold W. Scott, writing in the Jour. of Geol. (Vol. 43, No. 8) for the Amsden formation is (Upper Mississippian) middle or upper Chester for occurrences in North-Central Wyoming, Yellowstone Park, Wyoming and Southern Montana.

Since, Branson has recognized the position of the Amsden as straddling a systemic boundary in the Carboniferous, and has separated the Mississippian portion into a separate formation called "Sacajawea", referring to a type locality on Bull Lake creek with an age correlation of from Ste. Genevieve to Spergen, stressing Ste. Genevieve correlation. Assignment of the upper portion to the Pennsylvanian by C. C. Branson is based on faunal and stratigraphic evidence of its resemblance to the Tensleep formation.

Scott has shown that the Amsden formation overlaps the Heath and Otter members of the Big Snowy group in the Three Forks, Montana area.

In central Montana, the Amsden is overlain by the Ellis formation of upper Jurassic age. In neither the Judith Gap (in the little Belt Mountains) nor the canyon of the Musselshell River east of Delphine is there any apparent discordance of either erosional or angular character.

A collection of fossils by Girty offers abundant faunal evidence of the predominant Chester age of the Amsden, although there are some genera, younger and older, than Chester represented.

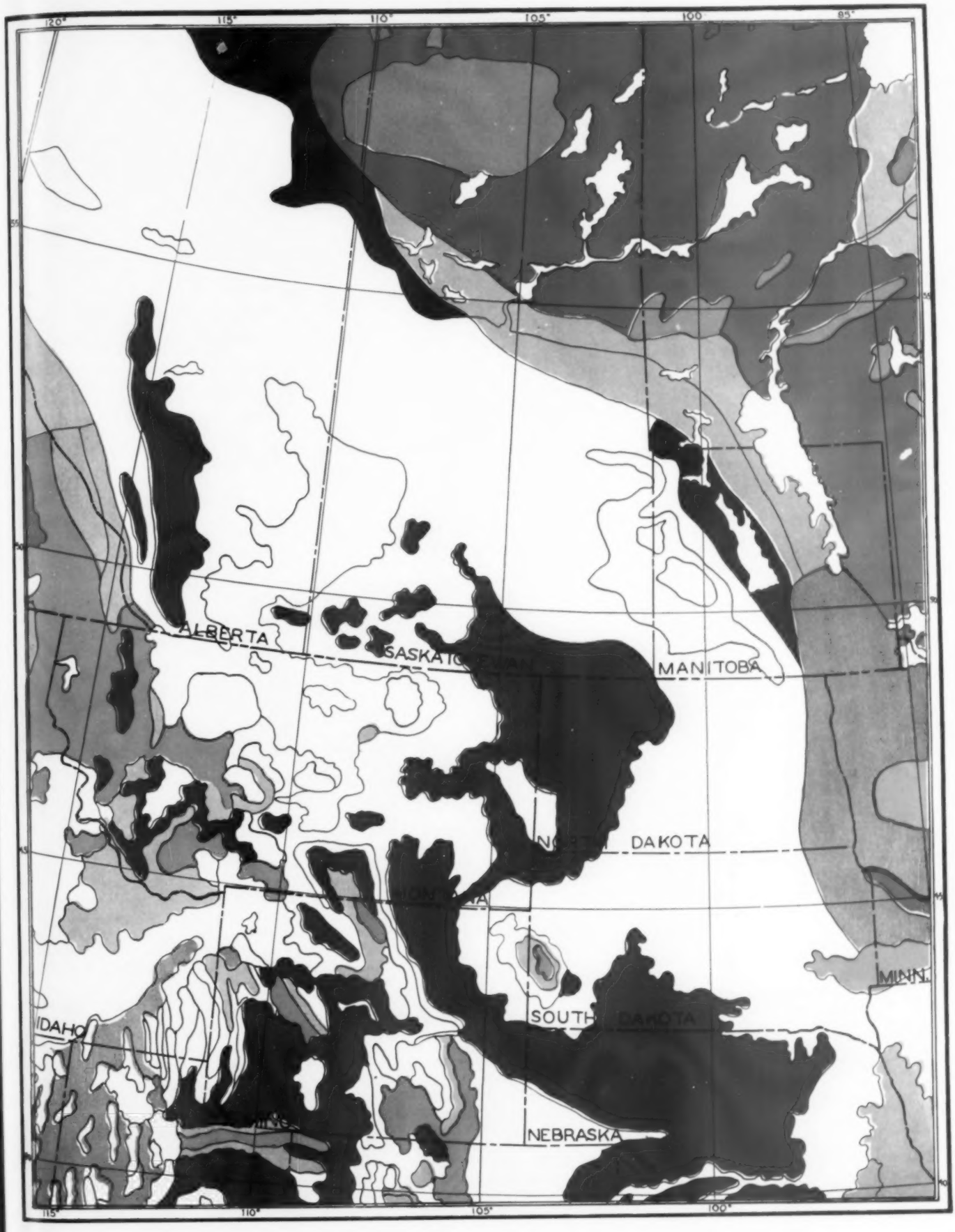
Big Snowy Basin. The Big Snowy basin described by Scott occupies the central portion of the Williston trough bounded on the west by a margin between Helena and Three Forks, Montana, and on the east by Minot, North Dakota. The axis of the trough strikes roughly east and west. The northwestern margin is probably limited by Great Falls, while the southwestern limits are limited by Bozeman. Greatest thicknesses are found northwest of Judith Gap, Montana, where more than 1,200 ft. of Big Snowy formations have been logged. At Ray in Williams county, North Dakota, only 400 ft. of Big Snowy formation was identified by Leach, in The California Company's No. 1 Nels Kamp test on the Nesson anticline.

The Big Snowy group occupies that group of strata that lies between the Osagian Madison limestone and the Amsden formation of central Montana. It drew its name from the Big Snowy Mountains of central Montana where excellent exposures and broad distribution are well developed. Excellent exposures of this formation are recorded in the Lombard Hills, Castle Mountains and the Little Belt Mountains by H. W. Scott.

The Big Snowy group begins with a basal red, thin-bedded, unfossiliferous marine sandstone averaging 120 ft. in thickness and displaying a persistent lithology—the Kibbey formation first named in 1899 by Weed, from exposures south of Kibby, Montana, the type locality. The Kibby rests upon an erosional surface in the Madison limestone. Overlying the Kibbey conformably is the Otter formation, a series of gray to green shales intercalated with fossiliferous and thin-oölitic limestones. A thin green shale in its upper part forms a lithologic marker. The Heath member, which conformably overlies the Otter marks the uppermost horizon of the Big Snowy group. It is principally a conodont-

Areal geology of the Northern Great Plains basin, after Charles Schuchert

Archeozoic	*Full Red*
Proterozoic	*Half Red*
Paleozoic	*Gray*
Devonian	*Black*
Mesozoic	*White*
Tertiary	*Full Blue*
Quarternary	*Half Blue*


120°
115°
110°
105°
100°
95°
ALBERTA
MANITOBA
DAKOTA
MINN.
IDAHO
SOUTH DAKOTA
NEBRASKA
115°
110°
105°
100°

bearing formation and its lithology is characterized by the black petroliferous shales and sand tones. On the outcrops in the Big Snowy Mountains and in the Little Belt Mountains west of Utica, the base of the Heath is composed of a black, petroliferous and fossiliferous shale. In most instances, the Heath member is conformably overlain by the Amsden formation, except where the latter is removed by pre-Jurassic and post-Mississippian erosions; for example, south of Lewiston, Montana, Upper Jurassic Ellis fossiliferous beds rest upon the Heath member.

Permo-Triassic. East of Casper, lower Triassic sediments occupy a broad area extending the full length of the Rocky Mountain front, with the exception of the northwest one-half of Montana. Stratigraphy of Lower Triassic is featured by an evaporite basin lying in extreme eastern Montana and western North Dakota. As much as 350 ft. of rock salt has been logged in the Permo-Triassic in eastern Montana in a test drilled on the Cedar Creek anticline, (Baker-Glendive). The Spearfish of Darton attains a thickness of 700 ft. in the north end of the Black Hills region and thins southward. The lithology consists principally of brick-red, sandy shales with a thick evaporite section near the base. The top of the Spearfish is marked by a gypsum bed at the top of the formation in the Black Hills region, but is absent further southward.

Lower Triassic sediments are called the Chugwater formation in Wyoming, from a type locality in the Laramie Range. Its deposition is regular and uniform; a thickness of 760 ft. is reported near Douglas.

West of Douglas, a thin, persistent limestone—the Alcova— an eastern tongue from the thick marine Lower Triassic limestones comes into the section according to John G. Bertram.

The Lower Permo-Triassic sediments in the Wind River mountains near Bull Lake in Fremont county, Wyoming, are comprised of the Permian Phosphoria, and the overlying Dinwoody and Chugwater formations. At Boxelder in Converse county, and at Casper Mountain in Natrona county, Wyoming, the sequence of the Permo-Triassic begins with the basal Opeche being overlain by the Minnekahta limestone and the Forelle limestone. An erosional unconformity separates the Pennsylvanian Tensleep from the overlying Permian rocks. In western central Wyoming, early Pennsylvanian rocks (Tensleep) are overlain by Middle Permian rocks (Phosphoria). However, to the east, the size of the hiatus diminishes so that the time break separates earliest Permian sediments (Hartville or Upper Casper) from superjacent Middle Permian rocks (Opeche) proving that the disconformity is found between rocks within the Permian. East and southeastward the hiatus is reduced to nil, so that in the mid-continent, continuous sedimentation marks the gradual transition from the Pennsylvanian and the Permian as outlined by H. D. Thomas.

Triassic. In the Banff aera, the Spray River formation of Lower Triassic age attains a thickness of 3,400 ft. and comprises arenaceaus shales, dolomites and marine limestones.

The Triassic sea extended southward from the Artic, but did not extend very far to the East. In the vicinity of Vermilion Chutes on the Lower Peace River, Cretaceous strata rest directly on Devonian limestones.

In the Peace River area, the Schooler Creek formation is believed to be of Upper Triassic age and comprises a lower member of grey, calcareous sandstones, arenaceous limestones, and calcareous shales which aggregate a thickness of 2,000 ft. These are overlain by chocolate, brown-purplish grey calcareous sandstone and impure limestone which attain a combined thickness of from 400 to 500 ft. No Triassic strata are known to occur east of the foothills of Peace River district, and it is believed they are absent from the Mackenzie Basin.

Lower Cretaceous. The Lower Cretaceous in the southern foothills of Alberta consists of the Kootenay and Blairmore formations, the latter with local development of volcanics.

Within the foothills the Kootenay thins markedly from west to east within a very short distance; therefore they probably do not extend for any great distance eastward under the plains of southern Alberta, where all the Lower Cretaceous may be equivalent to the Blairmore formation, according to Joseph S. Irwin, writing in the Bulletin of the A.A.P.G. (Vol. 15, No. 10). These are non-marine sediments and vary considerably in lithology and thickness. The contact of the Lower Cretaceous with the overlying Alberta shales is determined where red or green shale or greenish sandstones change to overlying, drab-grey shales or grey sandstones.

Upper Cretaceous. The Cordilleran land mass rose during Jurassic time in Idaho, western Utah, British Columbia and adjacent areas, with the eroded sedimentaries being washed into the surrounding area. During late Jurassic and all of Lower Cretaceous time, these sediments were spread over a great flood plain east of the Cordillera in the present Rocky Mountain region.

Beginning with the Upper Cretaceous, the sea spread throughout the floodplain east of the Cordillera, forming a marine basin extending from Utah 900 miles eastward to Minnesota and Iowa, and from Arizona and New Mexico on the south far into Canada and Alaska on the north, over an area exceeding 1,700,000 square miles. Greater limits may have been developed but subsequent, widespread erosion has removed much of the original Cretaceous deposits.

Greatest uplift of the Cordillera was close to southeastern Idaho and northeastern Utah. East of that locality, the Upper Cretaceous sediments ranged from 8,000 to 10,000 ft. in thickness, including much sandstone and coarser materials. However, throughout the greatest extent of the Rocky Mountain area, the marine basin was filled to a depth of 4,000 to 5,000 ft.

During Upper Cretaceous time, three great wedges of sandstone were projected into the shale body, thinning irregularly and disappearing to the east. Commercial coal beds are contained in these sandstone tongues and have been mapped in the western parts of Montana, Wyoming, Colorado, and New Mexico, and are referred to by John G. Bartram.

Due to the great distances throughout the Rocky Mountain province, and due to the late coordination of regional correlation data, a variety of nomenclature has developed for the same formation in different states. Bartram points out that the various formation names can be coordinated as follows; insofar as the three major sandstone tongues in the Upper Cretaceous are concerned:

UPPER: Mesaverde, Hygiene and Judith River formations;
MIDDLE: Eagle, Shannon, Emery, Virgelle, and Milk River;
LOWER: Frontier, Frontier, Codell, Mosby, Blackleaf, Tocito.

Cretaceous. In the southern Alberta-Montana region, the marine readvance of the Upper Cretaceous is represented by the Blairmore sandstone and its underlying conglomerate. Lying conformably upon the Blairmore is the Blackleaf shale member which represents the lower part of the Colorado shale. The basal part of this member has been suggested by Bauer and Robinson as being equivalent to the Dakota sandstone. However, the Comanchean - Cretaceous break is placed by Berry and Buckman within the Blairmore sandstone from paleobotanical evidence.

Overlying the Colorado shale is the Pierre group representing a series of intercalations of sandstone whose variations prove widespread oscillations of sedimentation. The Upper and Lower Milk River sandstone of Alberta is correlated by Michener with the Eagle of Montana, while the Lower Milk River designates that division regarded as the Virgelle of northern Montana. These are correlatives of the Hygiene of eastern Colorado, and probably the Shannon sandstones of Wyoming. Pakowki is a correlative of the Clagget beds, the latter having nomenclature priority in Montana; it occupies a considerable part of the Pierre group in eastern Alberta, but fingers out rapidly to the west.

Pakowki or Clagget shales are overlain by the Judith River formation, named east of the Sweetgrass Arch. It is the approximate equivalent of the Two Medicine formation of northwest Montana, the Mesaverde of Wyoming and Colorado, and the Pale and Foremost beds of southern Alberta.

The uppermost beds of the Pierre group, the Bearpaw marine shales are known in Wyoming as the Lewis shale. The Fox Hills sandstone in Alberta, the Dakotas and Colorado records the final deposition of the Montana group of seas. Because of its wide distribution, the Fox Hills is regarded as the best horizon marker in the Upper Cretaceous system. Upper Cretaceous is closed with the St. Mary River sandstone and shale—a continental deposit lying between the marine and brackish water Fox Hills below and the Willow Creek (Tertiary) sandstone and shale above.

The California Company's 10,281-ft. test in North Dakota in 1937.

Interpretation of Stratigraphy Nesson Anticline Exploration

The California Company (Subsidiary of the Standard Oil Company of Calif.)

No. 1 Nels Kamp,

Center Northwest Northeast Quarter, Sec. 3, T. 154, N., R. 96 W.

Williams County, North Dakota

Total depth 10,281 ft. Elevation, 1926 ft.

Drilling commenced Sept. 28, 1937; completed and abandoned Aug. 15, 1938.

Formations	From	To
EOCENE:		
Fort Union and Lance	0	850
UPPER CRETACEOUS:		
Fox Hills sandstone	850	1,030
Pierre shale	1,130	3,450
Niobrara (?)	3,340	3,580
Benton—Colorado shale	3,580	4,165
LOWER CRETACEOUS:		
Dakota Group (Fall River sandstone)	4,165	4,645
JURASSIC:		
Morrison	4,645	4,830
Sundance-Ellis (?)	4,830	5,585
PERMO-TRIASSIC:		
Spearfish	5,585	6,485
PERMIAN:		
Minnekahta limestone	6,485	6,561
Opeche formation	6,561	6,590
UPPER PENNSYLVANIAN:		
Minnelusa	6,590	7,060
LOWER PENNSYLVANIAN	7,060	7,720
Amsden (Top Madison-Mississippian 8,231 (?)	7,720	8,231
UPPER MISSISSIPPIAN:		
Big Snowy Group	8,231	8,631
Upper Osage-Keokuk	8,631	8,778
Upper Osage-Keokuk (Possible Burlington)	8,778	9,540
Kinderhook	9,540	10,281 TD

Formation tops furnished by Thomas W. Leach, Tulsa, Okla., consulting geologist now stationed at Bismarck, North Dakota.

LEGISLATION

South Dakota laws provide that the term of all oil and gas leases shall be for a period of two years and as long thereafter as oil and gas shall be produced from the leased land. Should production cease after the primary term of two years the lessee may begin drilling again within the time prescribed by the Board of School and Public Lands. The state receives one-eighth royalty on production except such oil as is used on the lease for further production. A reasonable annual rental is provided for by the Board of School and Public Lands. The lease may be cancelled for failure of the lessee to make the payment of rentals on nonperformance of the provisions of the lease.

The state geologist prescribes rules for conservation to prevent waste of the state's natural resources. It is specified that rules and regulations applying to public lands must conform to those issued by the Bureau of Mines and the Secretary of the Interior. Logs and reports must be filed with the state geologist.

A special bill was introduced into the South Dakota legislature early in 1941 to modify the present legislation to permit the leasing of oil and gas rights from fee owners for a 10-year period. Prior to the introduction of this bill, the law provided that no valid lease for a term greater than two years could be written, and that the state board of land commissioners reserved the right to extend the term of the lease for an additional five years, if in their opinion, the lessee had done geological work or development operations sufficient to warrant extension of the lease.

A survey of the oil and mineral resources of the state of South Dakota was made under the sponsorship of the South Dakota State Geological Survey during 1938 after the legislature had approved an appropriation of $25,000 for that purpose.

Governor Harlan J. Bushfield, in a recent address to the South Dakota legislature called attention to this survey, which covered all of the central portion of the state, stating that "as a result of that survey, most of the large oil companies are leasing and preparing to prospect for oil." He has requested a duplicate appropriation to resume the project.

PROSPECTS

Cambrian. A showing of oil was encountered in the Deadwood formation, (according to scout reports) of middle or upper Cambrian age, in a deep test drilled on the Camp Crook anticline in Harding county, South Dakota, on an en-echelon fold, between the Black Hills uplift and the Cedar Creek anticline. The showing was reported at a depth of 7,820 ft. at States Royalty Petroleum, Inc., No. 1 State, in the center-southwest northeast of Sec. 35, T. 18 N., R. 1 E., which was abandoned at a total depth of 7,918 ft. in that formation.

Devonian. The Devonian formation may be considered one of the possible producing formations for the Moose Jaw synclinorium. Bailey Willis in "Index to the Stratigraphy of North America," (U. S. Geol. Survey, Prof. Paper 71 (1912) p. 336), mentions that the Devonian is in places saturated with petroleum at the "Grand View" on the Mackenzie river, the shales being hard and fissile and blackened by crude oil.

Mississippian. One of the oil development objectives in the Williston basin proper of western North Dakota, eastern Montana

(Continued on page 60)

WORLD OIL PRODUCTION

All figures furnished direct to WORLD PETROLEUM by governments, except where otherwise specified. Figures in U. S. barrels of 42 gal.—Conversion ratios used are weighted averages for individual countries.

U. S. BARRELS — METRIC TONS

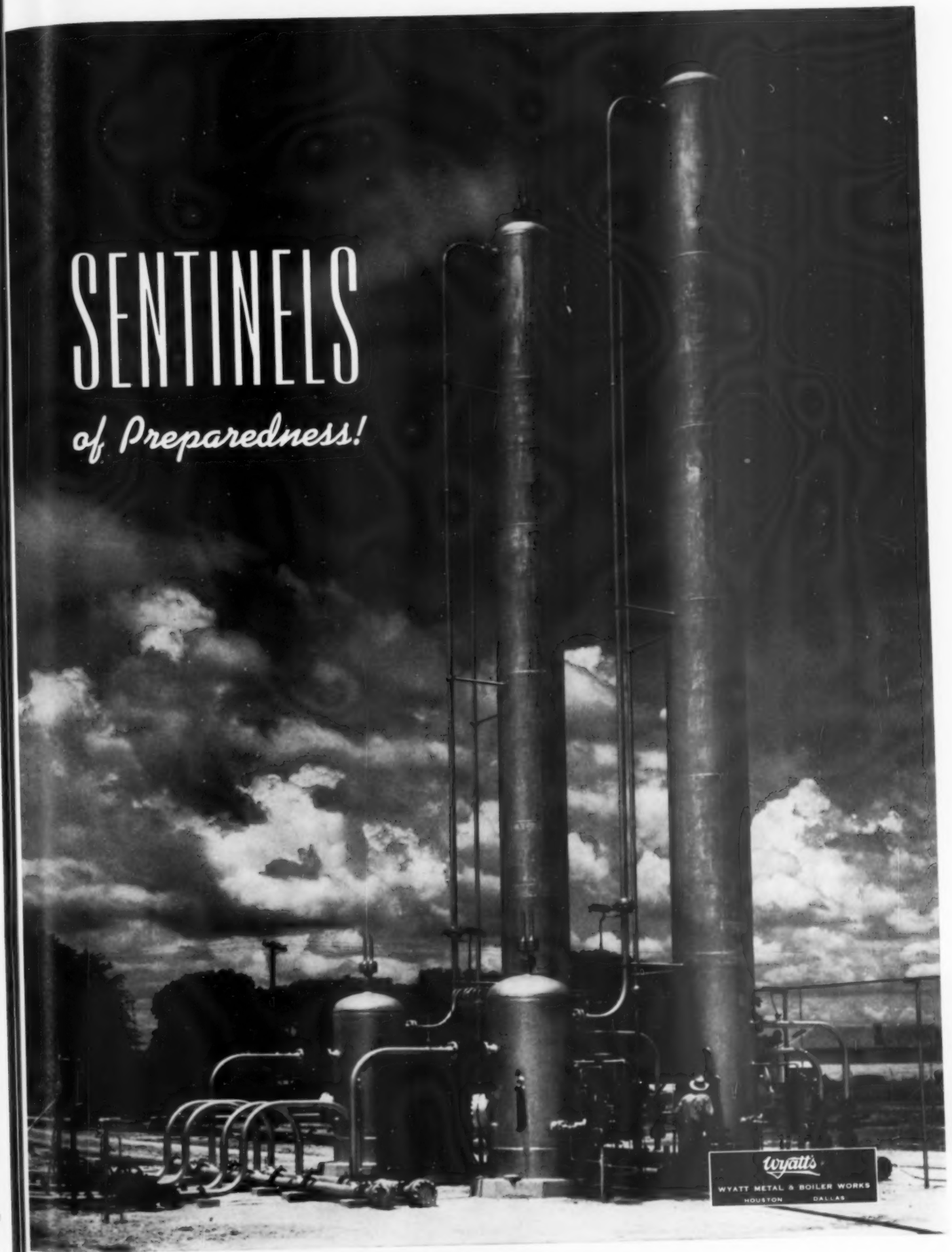
	Jan. 1941 Preliminary	Jan. 1940	Jan.-June* 1940	July-Dec.* 1940	Jan. 1941 Preliminary	Jan. 1940	Jan.-June* 1940	July-Dec.* 1940
United States	108,055,150	113,140,700	687,903,500	663,946,000	14,619,828	15,307,901	93,073,181	89,831,688
Soviet Union	18,900,000	18,406,932	108,709,066	108,200,000	2,592,592	2,508,024	14,860,032	14,842,245
Venezuela	15,249,057	14,798,667	98,162,773	86,598,468	2,264,151	2,197,278	14,575,022	12,857,976
Iran	6,560,000	6,637,503	39,127,171	40,024,504	870,000	880,493	5,190,340	5,253,206
Netherland India: Sumatra	3,345,000	3,472,786	20,293,738	20,293,248	426,300	444,602	2,586,081	2,586,128
Borneo	1,070,400	1,093,743	6,493,839	6,493,760	137,000	140,026	831,462	831,256
Java	537,600	561,064	3,261,898	3,261,564	69,200	71,830	417,944	419,038
Moluccas and Other	60,300	59,215	365,926	365,820	7,700	7,581	46,825	46,744
Rumania	3,100,000	3,786,908	23,136,925	20,094,204	420,338	513,479	3,137,210	2,724,636
Mexico	3,445,000	3,348,682	20,247,787	20,067,000	505,873	492,094	2,896,701	2,946,694
Iraq	1,000,000	2,615,129	15,525,007	8,700,000	133,672	349,556	2,076,862	1,162,016
Colombia	1,600,000	2,478,000	13,639,890	11,953,000	223,152	345,606	1,902,352	1,667,082
Trinidad	1,800,000	1,636,645	9,674,568	10,544,000	253,165	230,206	1,360,623	1,482,295
Argentine	1,775,000	1,671,378	9,867,017	10,618,749	252,849	238,088	1,405,556	1,512,641
Peru	1,000,000	1,154,037	6,713,284	6,272,000	132,013	152,737	888,211	827,984
Bahrein	650,000	631,644	3,647,288	3,448,853	88,700	86,195	497,864	470,638
Burma	657,600	666,810	3,989,529	3,989,440	90,500	92,101	549,120	549,064
Canada	800,000	486,859	3,681,029	5,037,024	101,807	61,957	468,441	640,999
Brunei	472,200	488,777	2,864,694	2,864,680	62,970	65,193	382,050	381,956
Great Germany: Old Reich	380,000	381,114	2,255,588	2,288,366	54,340	54,963	325,890	327,700
Ostmark	58,800	58,869	359,306	359,188	8,765	9,331	57,079	56,966
Slovakia and Moravia	9,800	10,137	59,363	59,412	1,470	1,519	8,918	8,918
Poland	320,700	331,049	1,945,814	1,945,642	43,000	44,392	261,076	260,980
Japan	217,470	225,308	1,319,326	1,319,318	31,000	32,178	188,487	188,170
British India	185,400	197,532	1,125,013	1,124,822	25,600	27,280	155,320	155,276
Ecuador	105,201	204,509	1,227,306	1,121,709	13,869	26,962	161,804	147,882
Saudi Arabia	467,900	491,663	2,588,938	2,775,672	63,400	66,604	350,715	376,070
Sarawak	108,000	112,716	659,221	657,964	13,370	14,539	84,843	83,632
Egypt	650,000	438,367	2,733,367	3,320,000	92,830	62,606	390,367	474,147
Italian Empire: Albania	135,000	118,358	711,820	785,304	20,233	17,670	106,500	117,699
Italy	4,000	6,650	32,550	24,800	500	820	4,030	3,080
France	40,000	42,532	249,458	246,962	5,610	5,952	34,944	34,634
Hungary	180,000	90,000	705,000	1,050,000	24,200	12,100	94,830	141,195
Bolivia	10,000	8,556	51,928	58,556	1,400	992	6,030	8,219
Other Countries	47,800	49,073	290,031	289,966	6,800	6,975	41,319	41,460
WORLD TOTAL	172,997,378	179,901,982	1,093,618,985	1,050,199,995	23,658,197	24,569,830	149,418,029	143,460,302

Official Crude Oil Production Figures for 1938 to 1940

Daily Averages

	Bbl.		Metric Tons		Bbl.			Metric Tons		
	Jan. 1941	Jan. 1940	Jan. 1941	Jan. 1940	1940	1939	1938	1940	1939	1938
United States	3,485,650	3,649,700	471,607	493,803	1,351,849,500	1,264,962,000	1,214,355,000	182,904,869	171,152,192	164,346,325
Soviet Union	609,677	593,772	83,632	80,904	216,909,066	216,727,024	206,192,000	29,702,277	29,530,168	28,859,000
Venezuela	491,905	477,376	73,037	70,879	184,761,241	205,783,650	188,429,050	27,432,998	30,533,706	27,845,286
Iran	211,613	214,113	28,064	28,403	79,151,675	78,151,332	78,320,840	10,443,546	10,367,117	10,358,495
Netherland India: Sumatra	107,903	112,025	13,751	14,342	40,586,986	41,557,013	34,538,128	5,172,209	5,320,320	4,662,836
Borneo	34,529	35,282	4,419	4,517	12,987,599	13,125,425	12,812,383	1,662,718	1,680,377	1,719,783
Java	17,342	18,098	2,232	2,317	6,523,462	6,568,714	6,955,283	836,982	842,237	933,595
Moluccs and Other	1,945	1,910	248	244	731,746	836,144	607,622	93,569	107,047	81,560
Rumania	100,000	122,158	13,559	16,563	42,406,250	46,020,000	48,366,000	5,750,000	6,240,000	6,603,000
Mexico	111,129	108,022	16,318	15,874	40,314,787	39,428,141	38,505,824	5,843,395	5,794,035	5,716,423
Iraq	32,161	84,359	4,312	11,276	24,225,007	30,791,132	32,404,000	3,238,878	4,115,845	4,345,000
Colombia	51,612	79,935	7,198	11,148	25,592,890	22,036,613	21,581,588	3,569,434	3,067,568	3,007,935
Trinidad	58,064	52,795	8,166	7,426	20,218,568	19,270,256	17,736,176	2,842,918	2,710,515	2,472,943
Argentine	57,258	53,915	8,156	7,680	20,485,766	18,738,003	17,076,237	2,918,197	2,657,232	2,432,857
Peru	32,161	32,258	4,258	4,927	12,985,284	13,587,906	15,908,279	1,716,195	1,798,557	9,099,885
Bahrein	20,968	20,375	2,861	2,780	7,096,141	7,588,554	8,297,998	968,502	1,045,391	1,130,734
Burma	212,129	21,510	2,919	2,971	7,978,969	7,872,981	7,499,498	1,098,184	1,087,424	1,039,960
Canada	25,806	15,705	3,284	1,998	8,718,053	7,837,503	6,965,457	1,109,440	997,487	879,921
Brunei	15,232	15,767	2,031	2,103	5,729,374	5,767,227	5,387,214	764,006	768,320	707,123
Great Germany: Old Reich	12,258	12,294	1,752	1,773	4,543,954	4,487,491	3,850,044	653,590	647,337	552,074
Ostmark	1,896	1,899	282	301	718,494	693,247	370,038	114,045	109,904	63,468
Slovakia and Moravia	316	327	47	49	118,775	119,380	132,005	17,836	18,103	19,282
Poland	10,345	10,679	1,387	1,432	3,891,456	3,898,044	3,828,438	521,984	522,874	504,678
Japan	7,015	7,268	1,000	1,038	2,638,644	2,652,930	2,511,184	376,657	379,161	356,328
British India	5,980	6,372	825	880	2,249,835	2,332,467	2,330,209	310,596	322,160	322,125
Ecuador	3,393	6,597	447	869	2,349,015	2,312,118	2,257,278	309,686	306,824	319,877
Saudi Arabia	15,093	15,860	2,045	2,148	5,364,610	3,933,904	495,135	726,765	536,366	66,683
Sarawak	3,484	3,636	431	469	1,317,185	1,329,645	1,624,882	168,475	171,322	200,126
Egypt	20,967	14,140	2,994	2,019	6,053,367	4,603,797	1,561,231	864,514	657,570	223,058
Italian Empire: Albania	4,355	3,818	652	570	1,497,124	1,393,727	437,597	224,199	208,279	65,313
Italy	129	214	16	26	57,350	91,330	106,083	7,110	11,346	13,178
France	1,290	1,372	181	192	496,420	500,815	516,240	69,578	70,478	72,106
Hungary	5,806	2,903	780	390	1,755,000	815,248	330,829	236,025	109,896	42,798
Bolivia	322	276	45	32	110,484	100,885	106,620	14,249	11,998	13,262
Other Countries	1,542	1,583	219	225	579,997	578,036	243,000	82,779	82,300	34,080
WORLD TOTAL	5,580,560	5,803,289	763,167	792,575	2,142,094,024	2,076,492,682	1,982,639,390	292,766,425	283,981,456	279,111,097

* Detailed monthly reports were published in February, 1941 issue.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HUNGARY'S EXPANDING OIL INDUSTRY

MOST noteworthy of the few additions to indigenous oil supplies in Central Europe in the past few years has been the rise of production in Hungary. Recent discoveries and increased drilling have brought the Hungarian output from 100 bbl. in 1936 to about 1,725,000 bbl. last year. Today production is at the rate of 2,000,000 bbl. annually, sufficient to meet the domestic needs of the country. It is possible that Germany may demand and receive a share of Hungary's oil. At any rate Germans are showing a keen interest in the possibilities of exploration in Hungary and a German concern has just received a concession for exploration and exploitation in the southeastern part of the country.

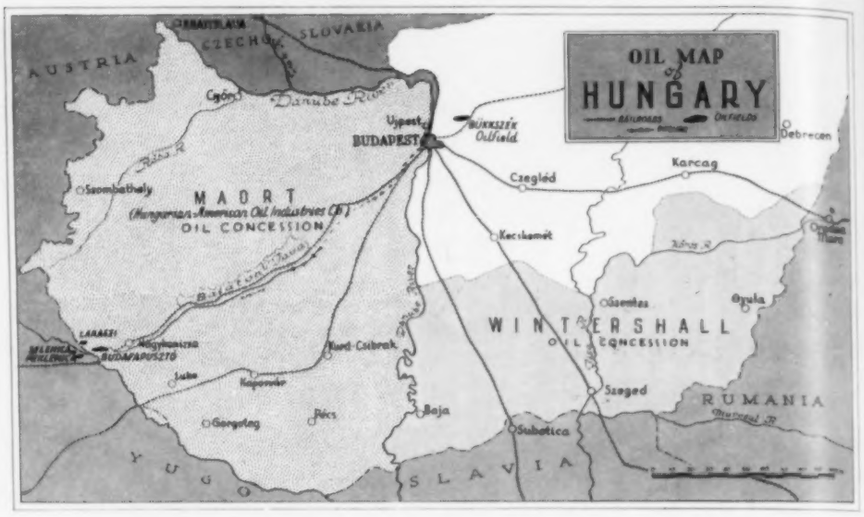
The main source of Hungary's increased production is the area formerly known as the Lispe field in the southwest which has been extended by recent additions of two other areas in this same general section. Output from these fields has been enlarged to an extent that justifies the construction of a pipeline from Budafapuszta to Budapest. This line has been completed for two-thirds of its length. A branch is projected from this line to a point near Acs where there is a refinery and river transportation.

Hungary's newest field, only recently proved, is located at Lovaszi and already has four wells producing an aggregate of 800-900 bbl. per day of 39 gravity API crude from 4,950 to 5,380 ft. The rotary drilling equipment used formerly came from the United States but is now supplied by German manufacturers. The field is being developed by the M. A. O. R. (Magyar Amerikai Olijipari, R. T., or Hungarian-American Oil Industries Company, of Budapest) which is an offshoot of the European Gas & Electric Company, Wilmington, Del. and Vienna, Austria, a subsidiary of Standard Oil Company (N. J). Indications are that drilling is being vigorously pushed, but no up-to-date figures are available from the parent company, communication being practically shut-off owing to the war.

There are 40 wells at the older field, located at Budafapuszta, formerly known as Lispe, and during 1940 the output averaged 5,200 bbl. per day from a depth of 3,960 ft. to 4,950 ft., the crude being of 41 gravity A. P. I. As at Lovaszi, rotary rigs are used for drilling. The pipeline runs from this field and will have a capacity of 37,000 bbl. per day when completed.

Northeast of Budapest, at Bukkszek, a government oil company has been drilling for some years and owns a total of 60 wells. The production however, is disappointing, being only 40 bbl. per day, and is falling off rather than increasing.

Since the first of the year a new exploration and exploitation concession has been granted in eastern Hungary to the well known German potash concern, Wintershall, A. G., which is affiliated with the Elwerath Company of Hannover, and conducts both production and refining operations in the Reich. The concession is for seven years, and its area is outlined on the accompanying map.



In Yugoslavia, just across the border from Lavaszi and Budafapuszta, are two small oilfields known as Selenico and Peklenico operated by the Yugo-Petrol group, formerly Rudokop. The A. G. I. P. of Rome two months ago acquired the controlling interest. The output per field is 8-10 bbl. per day.

ATLANTIC'S 100-OCTANE PLANT

A PLANT for the manufacture of 100-octane "super-aviation" gasoline for use in military aviation is planned by The Atlantic Refining Company at its Point Breeze Refinery, Robert H. Colley, president, announced in his annual report to stockholders on March 5.

"The plant will round out our facilities and enable us to contribute our full share to the national defense effort," Mr. Colley said. The project is now in the blue print stage, and it is contemplated that construction will get under way later in the year.

Pointing to the "increasing importance" of petroleum products in modern military and naval combat, Mr. Colley asserted there was now "a sound basis" for assuring the government and civilians their "utmost predictable needs" would be "surely and promptly met."

"It is important for our national welfare," he added, "not only that the military be supplied with unstinted quantities of products of the highest quality but that the supporting plants catering to the material welfare of the civilian population should not be impeded in their activities by restrictions in the use of petroleum products."

During the first World War Atlantic manufactured all of the "fighting grade" gasoline used by the American Expeditionary Forces abroad.

The new "super-aviation" gasoline unit is one item on Atlantic's refinery expansion program for 1941 which program totals $7,750,000.

Other additions to refinery equipment scheduled in 1941, it was reported, include a new catalytic cracking plant to supplement the new catalytic polymerization plant at the Point Breeze Refinery here, and an advanced type unit for the Atlantic Refinery at Atreco, Texas. These units will further improve the quality and increase the quantity of the gasoline output.

The company also will commence construction during 1941 of another crude oil distillation unit complete with desalting, catalytic desulphurization and hydrogen sulfide disposal equipment. The four units announced today will cost approximately $4,500,000.

Mr. Colley announced the company's new $1,300,000 terminal at Fort Mifflin on the Delaware River would be completed this summer. The terminal is intended to facilitate receipt of shipments of crude oil. It comprises a dock, four 80,000-gallon storage tanks, and two 16-inch pipe lines leading to the Point Breeze Refinery five miles distant.

Plans also were announced for building three more tankers after a fifth new 19,405-ton vessel is launched March 15. One vessel of this size will be delivered in the autumn of 1941, another in the spring of 1942, and a third of 13,000 tons early in 1943. The Atlantic fleet now comprises 23 vessels, with total dead-weight tonnage of 262,376 tons.

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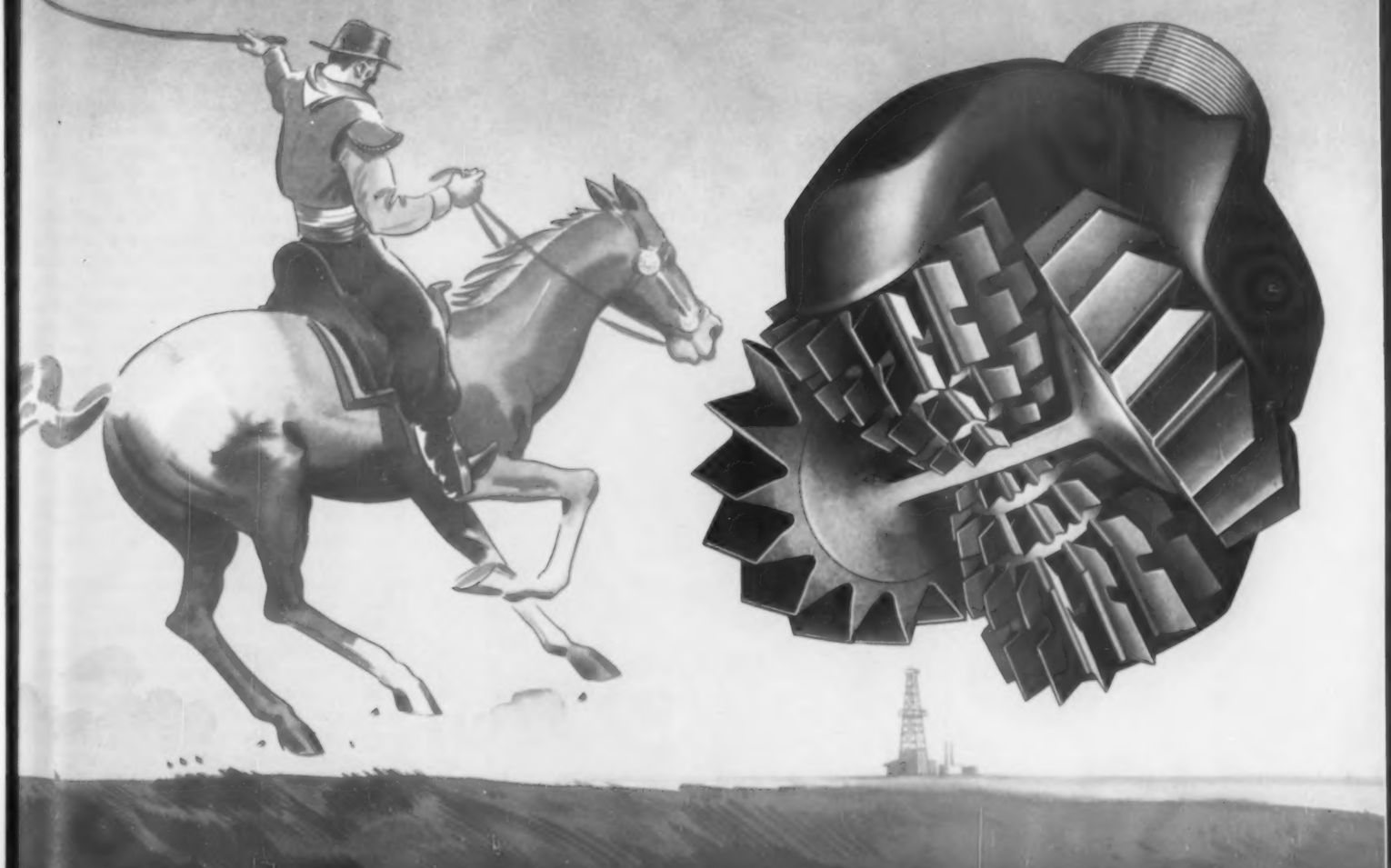
TYPE "CO"—*for drilling abrasive limes and shales*

TYPE "OSS"—*for drilling soft, sticky formations*

TYPE "OW"—*for drilling in medium hard shale*



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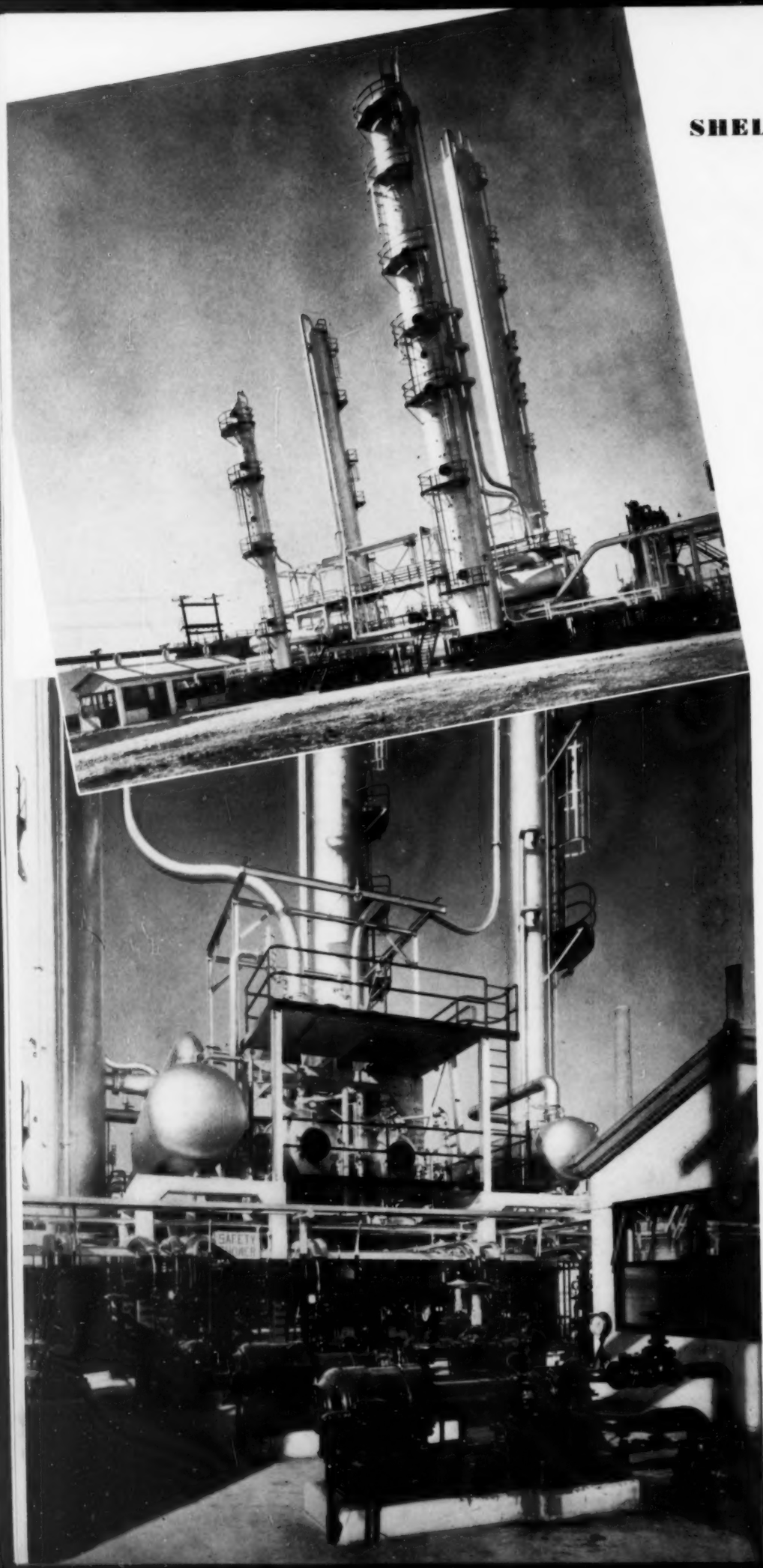


SHELL COMPANY OPERATES FIRST

THERE is now in operation at the Shell Oil Company's Houston refinery the first plant designed exclusively for the production of toluene from petroleum. This plant, which represents an investment of over half a million dollars, owes its origin to the current defense crisis which calls for an ample and assured supply of raw material for the manufacturer of high explosives. One or two similar plants are being constructed in connection with other refineries but are not yet in operation.

Shell's new toluene plant is essentially a simple fractionating unit which extracts toluene and other aromatics from selected fractions of certain crude oils, mostly crudes that are described as naphthene-base crude oils. It is this class of crudes in which the largest proportions of aromatic hydrocarbons, of which toluene is one, are usually found; paraffin-base crudes are usually poor in aromatics. Some naphthene-base crudes carry very high percentages of aromatics, particularly Roumanian and especially Borneo crudes which of all crude oils yet discovered carry the highest percentage. American crudes from the Mid-continent and Gulf Coast regions are much poorer in aromatics than these foreign oils, but they are still rich enough to make the extraction of toluene feasible, particularly in view of the greatly increased demand.

The accompanying illustrations show the heat exchangers, accumulators and fractionating equipment used in the plant; they give an impression of ordinary fractionating work, but it is all in the design. As a matter of fact, the extraction of toluene from petroleum is not at all a new thing, even for the Shell Oil Company. At various refineries of this company certain fractionating units have been set apart for making cuts rich in aromatics, particularly toluene, which are sold to paint and varnish makers who use them as diluents or thinners for their products. One of Shell's thinners, which is especially rich in toluene, is sold under the trade name of "Tolusol". The virtue of toluene and its associated aromatics in this use lies in their rapid evaporation which means quick drying of the paint or varnish.

However, a toluene which will satisfy varnish makers will generally not be pure enough for use in the manufacture of high explosives. It must contain no other aromatic hydrocarbons of lower or higher molecular weight which might make the explosive product more dangerous to handle or otherwise unsuitable. To produce toluene of military grade requires close fractionating which the new unit at Houston is designed to accomplish. Toluene boils at 241 deg. F., and is easily separated from its aromatic homologs, benzene (b.p. 176 deg. F.) and the xylenes (b.p. around 284 deg. F.). The chief difficulty in obtaining pure toluene from

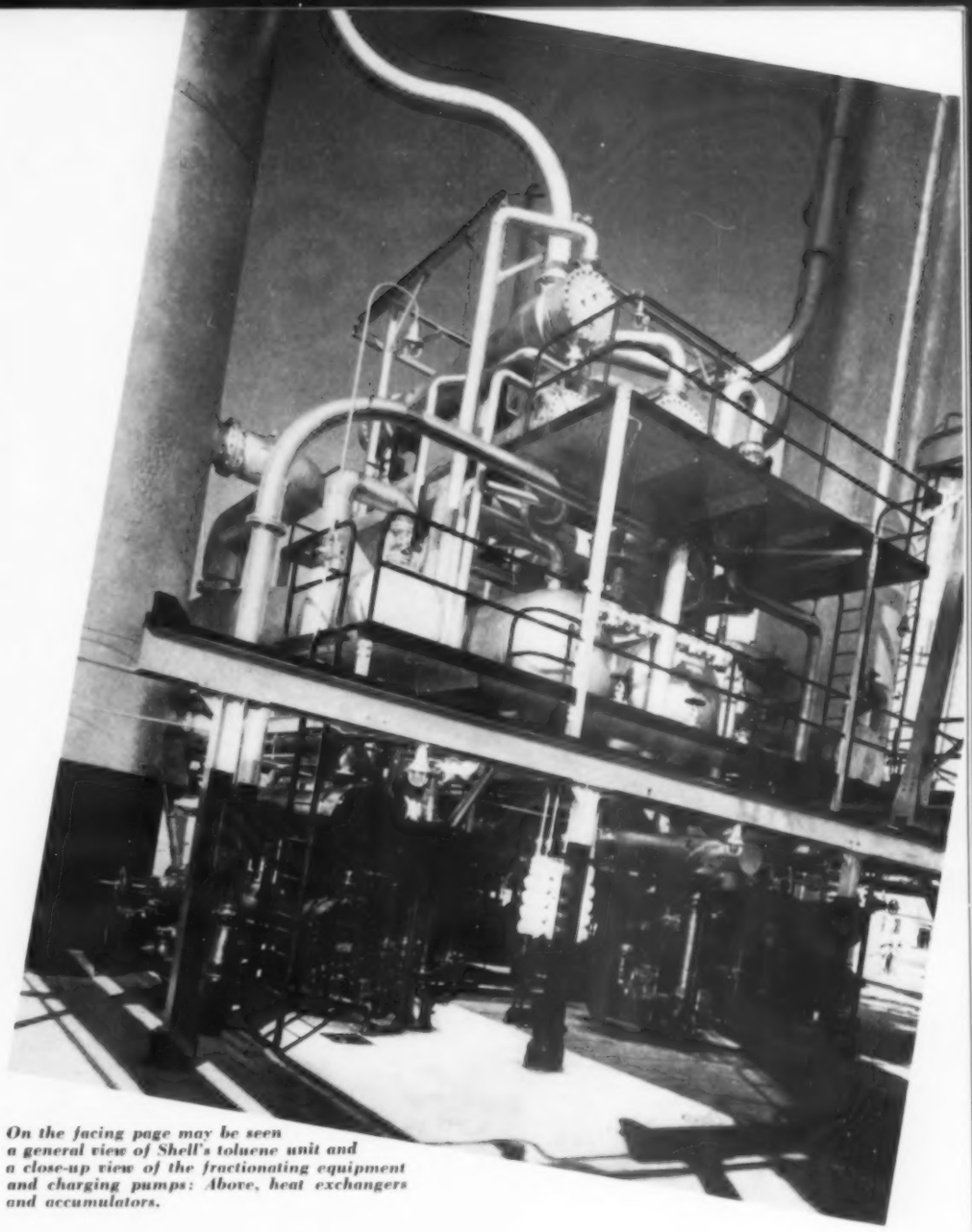
PRINT IN

...RST TOLUENE PLANT

petroleum is created by the necessity of removing paraffinic hydrocarbons which have boiling points close to that of toluene itself, but this is merely a matter of correct design of the fractionating tower.

The rated capacity of this toluene plant is about 2,000,000 gallons, or about 12,000,000 pounds of technically pure toluene a year. In the process of manufacturing trinitrotoluene (popularly known as T. N. T.) which is the principal high explosive used in military shells, bombs and torpedoes, three nitro groups (NO_2) are added to the toluene molecule, so that one pound of toluene is converted into about 2½ lbs. of T. N. T. On that basis a year's output of toluene from the Shell unit will provide about 30,000,000 pounds of high explosives. Assuming that a projectile of average caliber will require a charge of 100 lbs. of T. N. T. (some shells and torpedoes may contain 500 or more pounds) this would supply the army, the navy and the air force with 600,000 projectiles, which they might use for a year at the average rate of 1,660 a day. But the rate of consumption of projectiles in a large-scale modern war is unpredictable, and the defense authorities do not want to be caught on the short side. For this reason preparations have been made to establish other plants for extracting toluene from appropriate crudes. The available supply of such crudes is large and there is now slight reason for a repetition of the bottleneck condition that prevailed during the first world war. At that period raw material for high explosives was limited to the scant supply of aromatic hydrocarbons that was being obtained as a by-product from the dry distillation of bituminous coal in coke ovens and in gas manufacturing plants. During that time frantic efforts were made to obtain toluene from all possible sources, including petroleum, but in general with little success.

All that is now passed. The visible supply of toluene that exists in American crude oils will undoubtedly take care of any demand that may be reasonably be expected. Even if this supply of natural toluene should prove inadequate, an additional supply of immense proportions will be forthcoming. Toluene not only occurs ready made in some crude petroleum, but it may also be synthesized from other petroleum products by catalytic processes that have already passed the experimental stage, and on which the Shell Oil Company holds patents. In these processes appropriate fractions of paraffinic or other hydrocarbons are cracked under conditions such that the cracked products contain high proportions of aromatics and from which toluene and its homologus hydrocarbons are obtainable by fractional distillation. Shell officials estimate that if and when it becomes necessary to install this process at their Houston refinery they will be able to turn out 10,000,000 gallons a year, theoretically equivalent to 150,000,000 lbs. of T. N. T. Since the same performance can well be duplicated at other large oil refineries, it would seem that the T. N. T. problem is definitely laid to rest.



On the facing page may be seen a general view of Shell's toluene unit and a close-up view of the fractionating equipment and charging pumps: Above, heat exchangers and accumulators.

One reason why the coal-tar distilling industry is unable to meet the military demand for toluene is not only that the volume of its annual production is small but also because toluene is insistently required for other purposes, as in the paint and the dye industries. Unfortunately, no statistics are available to show how much toluene the coal tar distillers are producing. The business is confined to one or two companies; under these circumstances the Tariff Commission and other fiscal authorities refrain from publishing figures for domestic production. Besides the domestic business there is a considerable export business. Preliminary figures for 1940 indicate that exports of toluene amounted to 9,760,000 gallons valued at $3,152,459. Prior to 1940 toluene exports were not segregated from total exports of coal tar products.

German-Rumanian Agreement

THE German OEL UND KOHLE reports that the Reich and Rumania have agreed on a ten-year plan for the economic upbuilding of the latter country. The agreement provides that the Reich will grant long term credits for the promotion of all branches of Rumanian industry and agriculture under "especially favorable conditions," which include the furnishing of all kinds of machinery and equipment for railroads and oil pipe lines. German industrial, agricultural and other categories of experts will be placed at the dispcsal of the Rumanian government. As officially explained to the press by the Rumanian Economic Minister Cancicov, the agreement contemplates that 70 percent of Rumania's total exports and 80 percent of Rumanian oil exports shall go to the Reich, with a corresponding increase in the flow of German goods into Rumania.

NT IN BINDING

Foreign Oil Legion

EUGENE HOLMAN, director, Standard Oil Company, N. J., who recently gave a talk on oil transportation problems at the A. I. M. E. Petroleum Division dinner in New York, is now directing the transportation activities of the company.

G. M. KNEBEL, executive of the production department, and Eugene Stebinger, chief geologist, Standard Oil Company of New Jersey, lately returned to New York from a trip to San Domingo, Trinidad and Venezuela.

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George W. Gordon, president of Lago Oil and Transport, with Mrs. Gordon sailing from New York for a South American inspection trip.

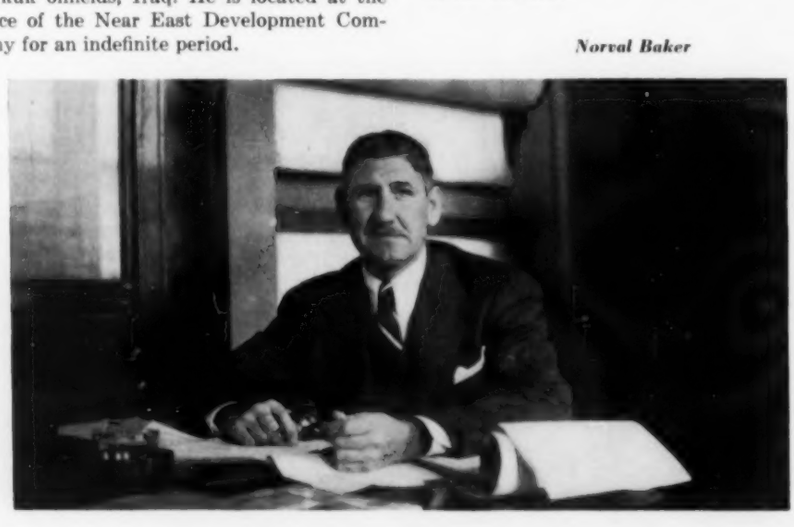
NORVAL BAKER, chief geologist, Iraq Petroleum Company, Ltd. is now in the United States, having returned from the Kirkuk oilfields, Iraq. He is located at the office of the Near East Development Company for an indefinite period.

Mr. and Mrs. John C. van Eck aboard the Santa Paula in New York harbor as they sailed on the same trip as Mr. and Mrs. Gordon for an inspection trip to South America. Mr. and Mrs. van Eck are being seen off by their daughters, Agnes and Marie.

F. B. KILLIAN, chief engineer, foreign automotive engineering division, Socony-Vacuum Oil Corporation, who has been with the company for about 35 years, is on a cruise to the West Indies. Mr. Killian was fortunate enough to win the cruise in connection with one of his clubs. One of his chief interests has been an exhaustive study of motor oil packaging, a subject which is again coming very much to the front in the United States.

WILLIAM G. THEISINGER, who since 1935 has been Welding and Metallurgical Engineer of Lukens Steel Company, Coatesville, Pa., has been appointed Director of Welding Research of the concern.

Norval Baker



W. F. Rockwell, Jr.

W. F. ROCKWELL, JR., vice president of the Pittsburgh Equitable Meter Co., will represent his company on an "industrial exploration tour" of the six South American American countries, March 17 to April 30, under the sponsorship of the National Research Council in cooperation with the Inter-American Development Commission in Washington. He will be a member of a party

of 28 key industrial, banking and research executives who will tour Colombia, Peru, Chile, Argentina, Uruguay and Brazil, and will submit a report on industrialization possibilities to the Department of Commerce, the Inter-American Development Commission, and other interested government departments and agencies on its return. The trip will be made entirely by air in a chartered plane of Pan-American Airways.

As a participant in the National Research Council South American trip, Mr. Rockwell will be guest to Secretary of Commerce Jesse H. Jones, Nelson A. Rockefeller and William S. Batt, Chairman of the Research Council at a dinner to be held in Washington March 14.

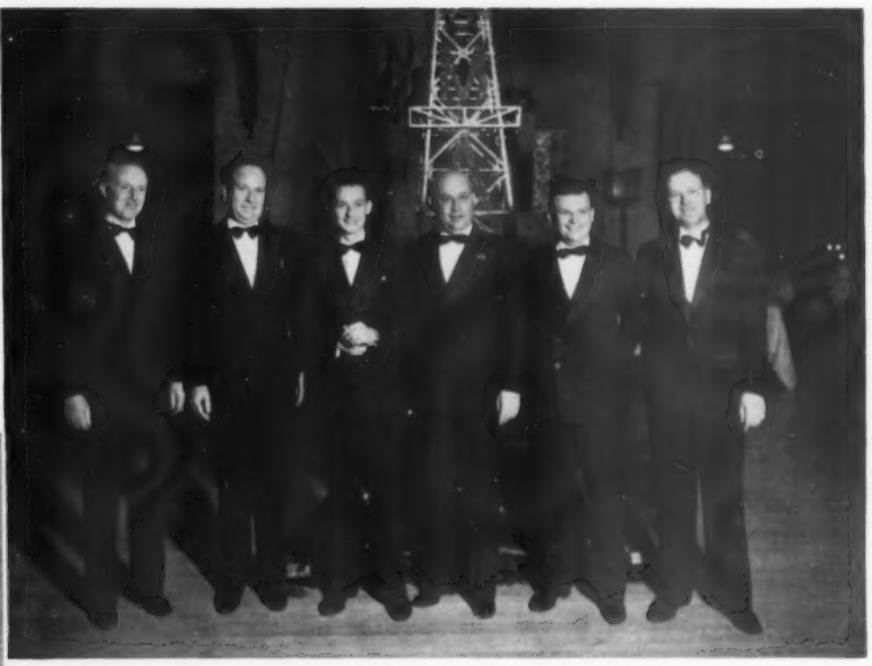
Mr. and Mrs. S. M. Wynn sailing from New York on February 7 for South America.

HARRY F. SINCLAIR, whose Consolidated subsidiary, Venezuelan Petroleum Co. recently brought in an important discovery well in Eastern Venezuela, returned from Venezuela to New York with Earl Sinclair, Daniel Pierce and D. M. Engle on March 13 aboard the Santa Paula.

ANNOUNCEMENT has been made of the appointment of Harold C. Eddy to the position of general manager of Petroleum Rectifying Company of California.

In length of service, Mr. Eddy is the oldest member of the Petreco organization, having been with the company for twenty-seven years. He is a graduate of Colorado School of Mines and one of the pioneers in crude oil dehydration work. For the past few years he has been actively engaged in developing and perfecting the Petreco Electrical Desalting Process. He is the author of numerous articles and papers on crude oil dehydration and desalting and is recognized as one of the leading authorities on these subjects. Numerous patents covering improved processes and apparatus have been issued to him. His work with the company has kept him in close touch with all phases of the business, including field work, research, engineering and business administration.

Mr. Eddy enjoys a wide acquaintance throughout the oil industry and his many friends will be gratified to learn of his advancement.



Left to Right: Earl Rees, Bob Eiche, Bill Bettis, Ernie Fowks, Elmer Smith and Roy Hitchcock, new officers of Los Angeles Nomads.

THE Second Annual Inaugural Dinner Dance of the Los Angeles Chapter of Nomads in honor of its new and retiring officers was held at the Wilshire Country Club on Friday evening, February 14th. Guests included foreign visitors as well as oil company and equipment men.

The new officers of the Nomads are: E. B. Fowks, president; W. F. Bettis, vice-president; Earl M. Rees, secretary-treasurer; Elmer R. Smith, assistant secretary-treasurer R. J. Eiche, sgt.-at-arms; and Roy Hitchcock, deputy sgt.-at-arms. Regents elected to the national organization are T. Sutter and W. F. Bettis.

C. W. HAMILTON, vice president, Gulf Exploration Company, will shortly be back from a trip to Panama, Venezuela and other places in the Caribbean Sea. Part of his visit is in connection with some new property which will shortly be explored. Company geologists already are making preliminary studies.

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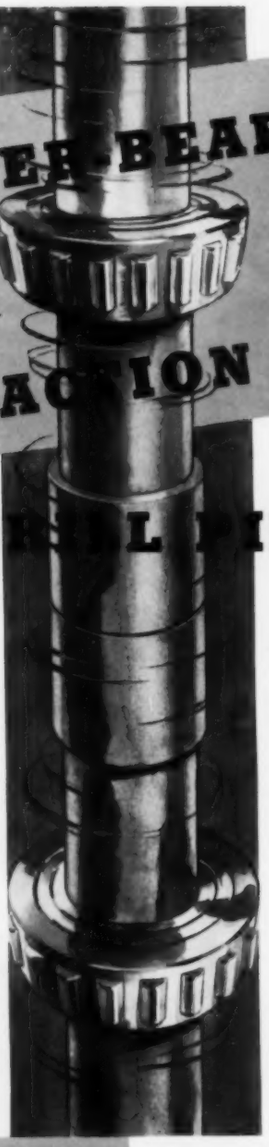

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PATENT LICENSES, unrestricted as to sources of supply of materials but on royalty bases, will be granted to responsible oil companies and operators to practice the inventions of any and / or all of United States Patents Nos. 1,575,944; 1,575,945; 1,807,082 and 1,991,637 and further improvements thereof. Applications for such licenses should be made to the Los Angeles office.

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Fred R. Schroeder, geologist, Union Producing Company

FRED R. SCHROEDER of Shreveport was recently appointed to the position of superintendent of the geological department according to an announcement by officials of Union Producing company, associated company of United Gas Pipe Line Company.

S. A. Scherbatskoy

S. A. SCHERBATSKOY was elected vice president at the annual meeting of the directors of Well Surveys, Inc., Mr. Scherbatskoy was, during the past five years, Director of Research of Engineering Laboratories, Inc., and in charge of instrument research for Seismograph Service Corporation. Recently, he became very actively engaged in organizing and supervising the development in radioactivity well logging which is being carried on by Well Surveys, Inc. Prior to his work in the oil industry, Mr. Scherbatskoy was engaged in research and development in the Bell Telephone laboratories.

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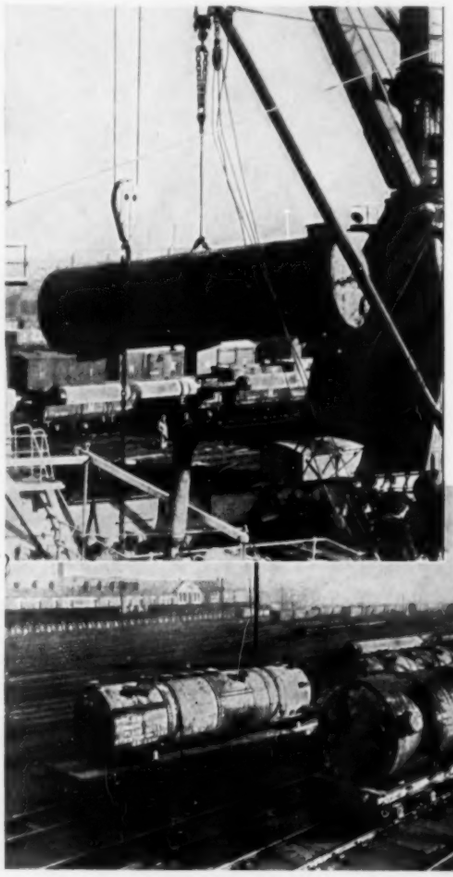

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GREAT PLAINS

(Continued from page 49)

and southwestern Manitoba and southeastern Saskatchewan, is the Big Snowy group. (This formational group, which occupies the deepest structural contours of the Williston basin, is described elsewhere in this report under stratigraphy.) Its age is Upper Mississippian, younger than Osage. Widespread peneplanation and base-levelling in the major hiatus that following the deposition of the Mississippian has truncated much of the original thickness although it attains a maximum thickness of approximately 1,200 ft. in east-central Montana, (see isopachous contour map in this report).

Oil production possibilities of this formation have been heightened in recent years by the successful usage of acid treatment in the development of commercial oil production at Turner Valley and specifically in the new Steveville discovery oil well from the Mississippian Madison, of southern Alberta.

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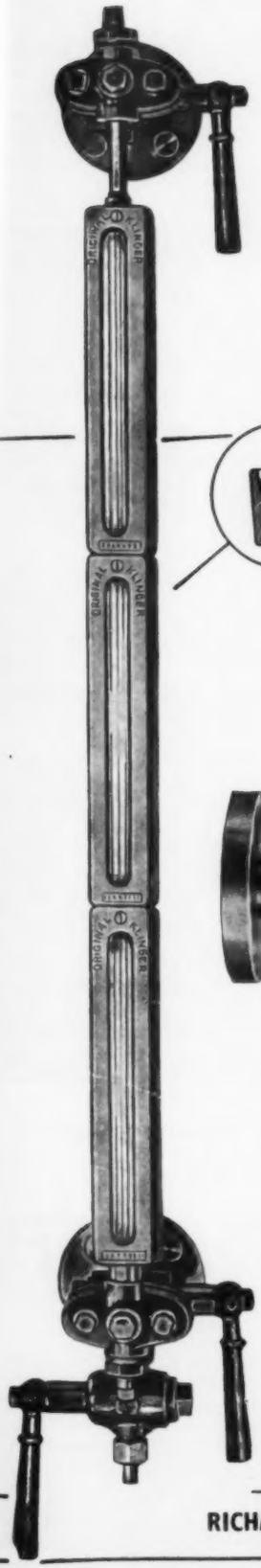

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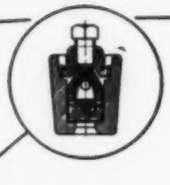

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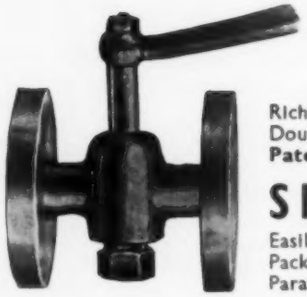

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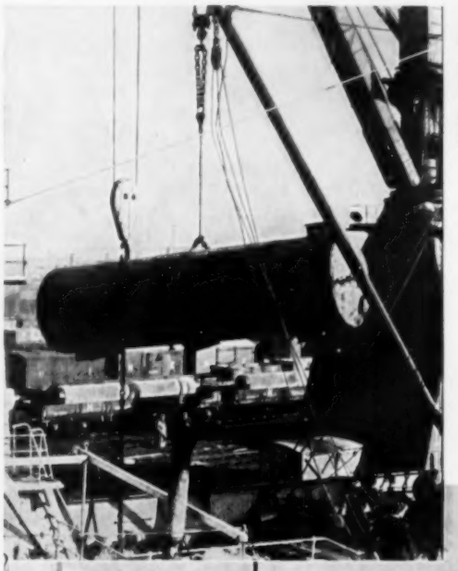

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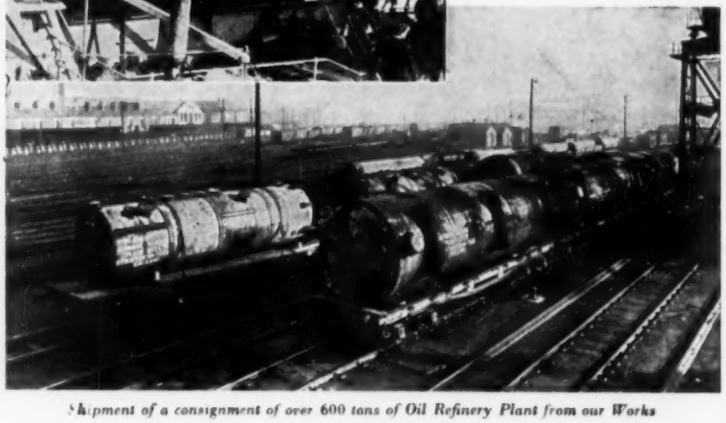

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GREAT PLAINS

(Continued from page 49)

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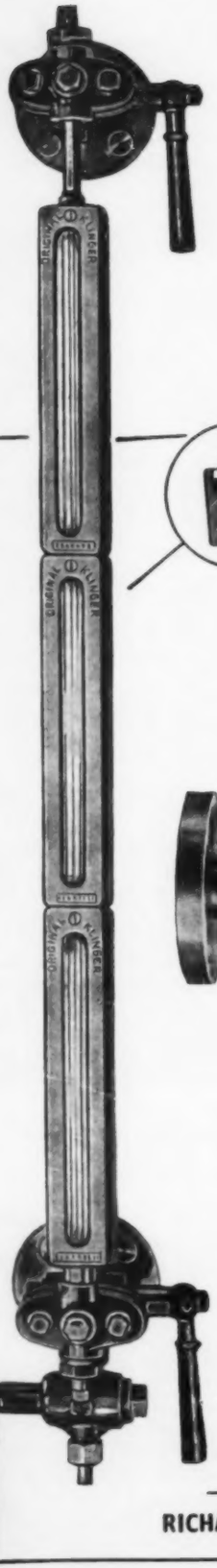

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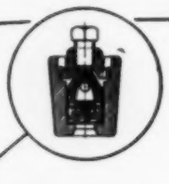

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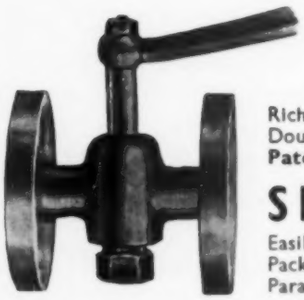

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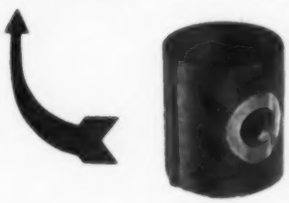

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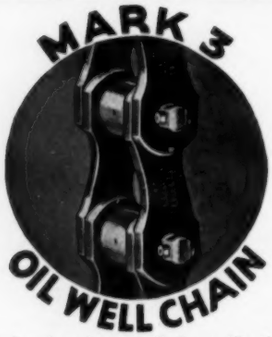

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North Dakota. In the deep test drilled to the Paleozoic sediments on the Nesson anticline near Ray in Williams county, North Dakota, by The California Company, at their No. 1 Nels Kamp, H. N. Hickey of the producing department of The California Company writes that "few faint odors were noticed from cores taken from the lower part of the well . . . although no actual shows of oil and gas were encountered." Description of No. 1 Nels Kamp is the center Northwest Northeast Quarter, Section 3, Township 154 North, Range 96 West.

Jurassic. In describing the oil and gas possibilities of Saskatchewan province, G. S. Hume points to the Jurassic as a possible petroleum objective. He states that "it is likely to be found in the sands of the shoreline of the former Jurassic sea or in the sands of the Lower Cretaceous where these end against the Jurassic or overlap onto the Jurassic ridge. It is thought that, in southern Alberta, Jurassic shales are source beds of oil. If so, they are possible source rocks in southwestern Saskatchewan."

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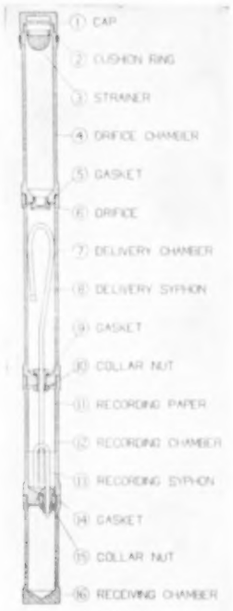

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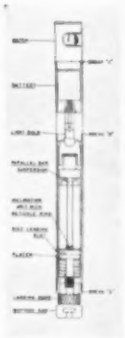

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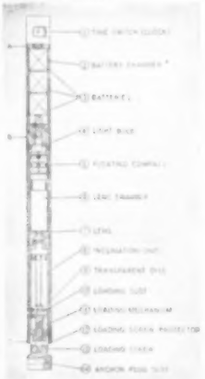

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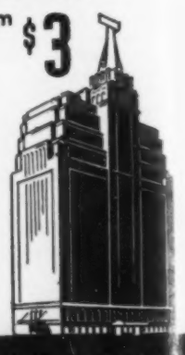

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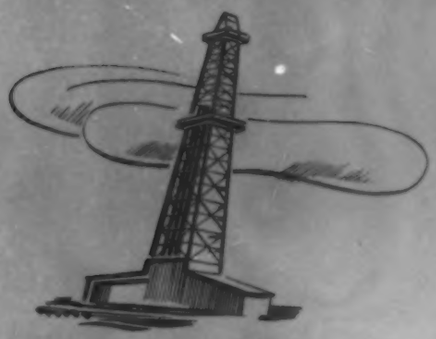

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EMCO GAS METERS
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EMCO Cast Iron Meters

Widely used for domestic or small industrial services where installed in exposed locations. Completely described in Bulletin 1000.

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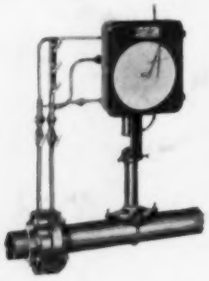
De mucho uso en servicios domésticos y servicios industriales limitados, donde quedan instalados en puntos expuestos. Completamente descritos en el boletín 1000.



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Compact instrument style meters operating by the orifice principle for measuring extremely large volumes. Completely described in Bulletin 1050.

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Contadores compactos, de estilo de instrumento, que funcionan sobre el principio de orificio para medir grandes cantidades. Completamente descritos en el boletín 1050

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Heavy duty, rugged meters for large volumes, high pressure field and industrial services. Completely described in Bulletin 1003.

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Contadores durables, de trabajo pesado, para grandes cantidades, para servicios de alta presión en campos e industrias. Completamente descritos en el boletín 1003.

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EMCO Ejector Service Regulator

Especially designed for domestic house service to reduce high inlet pressures to constant, safe utilization pressures. Completely described in Bulletin 1026.

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Especialmente proyectado para servicio doméstico de casa, para reducir las altas presiones de entrada a presiones de utilización constantes y seguras Descripción completa en el boletín 1026.

EMCO Balanced Valve Regulators

Made in both high and low pressure types, for large volume, pipe line service. Completely described in Bulletin 1006.

Reguladores EMCO de Válvula Compensada

Se ofrecen en tipos para alta y para baja presión, para gran cantidad de servicio de línea de tubería. Completamente descritos en el boletín 1006.

EMCO "1001" Regulator

For controlling the pressure at town border stations, small distribution sections and to industrial consumers. Extremely flexible in control range. Completely described in Bulletin 1059.

Regulador EMCO "1001"

Para gobernar la presión en estaciones cerca de pueblo, pequeñas secciones de distribución y para consumidores industriales. Extremadamente flexible en escala de gobierno. Completamente descrito en el boletín 1059.

PITTSBURGH GASOLINE AND OIL METERS
CONTADORES PITTSBURGH DE GASOLINA Y PETROLEO

Pittsburgh Piston Meters

Made in both two and four cylinder types. Widely used for measuring refined petroleum products, due to extreme accuracy of measurement. Completely described in Bulletin O.G. 103.

Contadores Pittsburgh de Embolo

Ofrecidos en tipos de dos y de cuatro cilindros. Se usan mucho para medir productos de petróleo refinados, debido a su extrema exactitud en medición. Completamente descritos en el boletín O.G. 103.

Pittsburgh Rotocycle Pipe Line Meters

The first meter designed primarily for this particular service—for measuring large volumes of crude or refined petroleum products being transported in pipe lines. Completely described in Bulletin O.G. 125.

Contadores Pittsburgh Rotocycle para Línea de Tubería

El primer contador primariamente proyectado para este servicio particular—para medir grandes cantibades de productos crudos o refinados de petróleo, transportados por líneas de tubería. Completamente descritos en el boletín O.G. 125

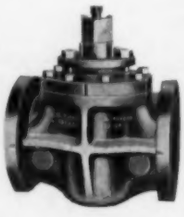
Pittsburgh Rotocycle Meters

Extremely accurate, sensitive meters of the rotary type, for use on bulk plants and tank trucks. Completely described in Bulletin O.G. 127.

Contadores Pittsburgh Rotocycle

Contadores extremadamente exactos y sensitivos, del tipo giratorio, para uso en plantas grandes y camiones tanques o cisternas. Descritos en detalle en el boletín O.G. 127.

NORDSTROM LUBRICATED PLUG VALVES
VALVULAS DE TAPON NORDSTROM LUBRICADAS



Nordstrom Standard Valves

"Sealdport" lubrication forces lubricant under high pressure between the plug and body, making the valve leak-resistant and freeing the plug to assure easy operation. Completely described in Bulletin V-108.

Válvulas Nordstrom Normales

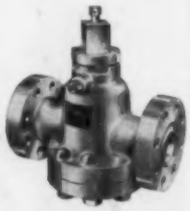
La lubricación "Sealdport" inyecta lubricante bajo alta presión entre el tapón y el cuerpo, haciendo la válvula resistente al escape y lirando al tapón, para asegurar fácil funcionamiento. Completamente descritas en el boletín V-108.

EMCO-NORDSTROM Valves

Have standard gate valve face-to-face dimensions Can be used to replace valves of other types without altering existing pipe dimensions Completely described in Bulletin V-108.

Válvulas EMCO-NORDSTROM

Tienen las dimensiones normales de cara a cara de la válvula de compuerta. Puede usarse en lugar de otros tipos de válvula, sin alterar las existentes dimensiones del tubo. Completamente descritas en el boletín V-108.



Nordstrom Hypreseal Valves

For super valve service, at extreme temperatures and pressures. Can be furnished Merchromed for the utmost resistance to high temperature, corrosion and erosion. Completely described in Bulletin V-107.

Válvula Nordstrom Hypreseal

Para servicio superexcelente de válvula, a temperaturas y presiones extremas. Puede suministrarse tratada con mercurio y cromo para maxima resistencia a la alta temperatura, corrosión y erosión. Completamente descrita en el boletín V-107.

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